TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. XII, No. 2. FEBRUARY, 1935. PRICE 6d.

CONTENTS.

	PAGE.
The Place of Fisheries Work in the Tropics	29
Experiments in Fish Preserving	30
Sudan Fodder Grasses	34
Biological Manures	34
Gummosis of Citrus in Trinidad	36
Sugar Notes	42
Agricultural Labour in Trinidad (*Continued*)	43
Miscellaneous Notes	47
The World's Cotton Position	48
Chemical Notes	51
Trend of the Markets	52

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

Cables :: "Stomata." | Phone :: 2183

TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C.3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

THE PLACE OF FISHERIES WORK IN THE TROPICS.

THE older view of the equatorial forests was that Nature had there provided vast reserves of timber, rich soil, plant foods and organic residues lying waiting for the time when pressure of population should lead mankind to exploit them. The trend of modern reports is that these forests operate on a comparatively small capital of plant foods circulating with a rapidity of turnover undreamed of in temperate forests. These reserves are anything but inexhaustible, and exploitation without the utmost care leads to devastation through wastage of organic residues, loss of soil, upset of the balance of species and so on. It is in fact a most delicate matter to manage such enterprises.

So too with fisheries in temperate waters: while populations were smaller and the general consumption of fish limited, through slow transport, to the coastal populations, the seas were considered as inexhaustible sources of wild fish. The present century has seen the passing of that conception, and trawlers now make ocean voyages with all the resources of refrigeration, of floating bases, mother ships speeding to market with the catch and back again with stores. The oceans are not inexhaustible. A given area can support only so much of basic food supply, plankton and what not, and upon it, each in its due balance only, the succession of species preying upon each other. For each species Nature strikes a balance between reproduction and enemies, between food supply and natural rates of growth. Good years or bad years only move the general level upwards or downwards to some extent. Eventually we hope we shall have knowledge enough to "farm" the seas from year to year with fore-knowledge and restraint as even now grouse-moors and trout streams are preserved having regard to what breeding stock must be spared, what enemies destroyed, what protection afforded during the breeding season.

The diet of many fine cultivating populations crowded densely on fertile areas in the tropics is perhaps too largely vegetarian for full physical and mental efficiency, even at times to the point of deficiency diseases. In Africa deficiency diseases are known among cattle even, owing to the poverty of the grasses. Assuming that enlightenment and a desire for higher standards of living spread, how could the resulting call for a better diet in practice be met? The depression

conditions of the past few years have perhaps obscured the fact that the time is already in sight when in the world's meat markets the demands of the white populations will overrun the supplies. Countries which a few years back were exporters now have begun to import. Thus meat at competitive world prices plus the cost of cold storage in transit and at destination is not likely to be the solution of this diet problem. The dried salt cod already largely imported into the West Indies points an alternative—but why import from afar while there are available supplies in rivers, lakes, seaboards and open seas closer home ?

Localised longshore fishing already goes on in the tropics to the point even that in some places serious deterioration is reported within the last decade, yet little towards a systematic exploitation of tropical fisheries, whether longshore, offshore, or freshwater, has been attempted.

The one all important rule of sound farming, forestry, hunting or fishery is not to attempt in a year to take from your land or water more than Nature (with what help you can profitably afford her) can in a year restore through the natural rates of reproduction and growth. Our ignorance as to what Nature can do in the tropical waters is abysmal, and to prevent further overfishing of the inshore waters as well as to plan sound and systematic fishery developments for the future, it is high time to begin the necessary stocktaking of our tropical waters.

In Britain such work is the care of the Fisheries section in the Ministry of Agriculture and Fisheries. As yet in the tropical seas, rivers and lakes, not much has been done to study and preserve the fisheries in any general way. In East Africa a valuable preliminary survey of the major lakes of Kenya and Uganda was made by the Cambridge University Expeditions between 1928 and 1931. In some cases the establishment carries a fisheries officer or so, in others fishery is the part-time care of some department primarily concerned with other duties—coast-guard work for instance—in others they receive no official concern beyond a few negative regulations as to species undesirable as food, or size limits, tagged on to public health or market inspection codes. Results must depend entirely on the interest and keenness devoted to such side shows by the officials, and in practice little more results perhaps than a sporadic "gingering-up" of fishermen. Rules as to close seasons and size limits can be of only dubious value till they can be soundly based on biological study, and information as to the life history, breeding habits, growth rates and bionomics of each species under regard. Usually far more consideration has been paid to quickly exhausted, get-rich-quick products such as pearls, shell, sponges and bêche de mer, than to food for the native.

In most areas the species have generally been catalogued, incompletely, and decades back by visiting expeditions. Beyond this nothing has been attempted in a general way, although scattered voluntary contributions, spare-time studies by local officials engaged on other duties, are found. Of such it is not surprising to find that medical officers interested in natural history and grounded in general zoology for first M.B. examinations have contributed most frequently. Given the necessary elementary biological knowledge it is in most places possible for any interested competent observer without specialised training or equipment to make valuable contributions to knowledge of the country's fish if he will but keep records from year to year. These qualifications are surely well met by the majority of agricultural and forest officers. It involves little labour and affords much interest to learn to know the species found, to record their relative abundance, the useful and the useless or harmful, which preys upon which, and how they are caught.

It may be surmised from these observations that there is need for careful consideration of the general future policy of fisheries work in the tropical dependencies. Such work, if properly organised, would undoubtedly offer great possibilities and it is hoped that an early opportunity will be taken to consider how best it could be fitted into the cadre of existing colonial administrative organisations.

F. E. K.

EXPERIMENTS IN FISH PRESERVING.

By F. E. Kenchington, M.Sc.

Fish and Native Diet.

Over much of Africa millet forms the bulk of the native diet, over most of the remainder maize, among the food grains notably two of the poorest in analysis and balance. It is noteworthy that throughout Africa the virile dominant races, the active overlords of their more sluggish neighbours are, when at peace, herdsmen. In their diet grain is at a minimum, while the flesh, milk, and milk products from their beasts predominate. The desert Bedaween, Bisharin Beja and Hadendowa ("Fuzzies") of the Sudan, and the Masai of East Africa at once spring to mind. It is probable, nay certain, that factors other than diet share in producing this difference. How far the diet is a result of the restrictions of their habitat, or how far they live where and how they do from preference, might be argued at length and inconclusively. Yet previous occupation of a more desired territory need not, one feels, in the immediate past seriously have restricted entry by tribes so able in warfare as these. The legal defining and permanent circumscribing of tribal territories, hardly complete as yet, was scarce begun forty years back, so that even within the lifetime of living native elders all Africa was open

to penetration by any dissatisfied tribe of good soldiers. Space for a closer occupation in the cultivable areas exists even now.

Geologically Africa is one of the oldest land masses of the world. In the cretaceous age the sea of Tethys, the gigantic prototype of the present Mediterranean may have covered North Africa to the latitude of about the first cataract of the Nile. Most of the rest of the continent has probably not been submerged and renewed beneath a sea since primary or even protean times. Slow wastage and losses in circulation through such ages may well have led to a relatively acute shortage of the valuable sea salts. There may be shortage also of rarer elements essential to the formation of the subtle accessory diet factors knowledge of which is a matter of only a decade or two, and the importance of which is out of all proportion to the minute traces in which they are necessary. It is well known how much Africans prize salt even to using it as currency which may well signify an unconscious realisation of these needs. The mainly vegetarian races commonly have a prominent abdomen, due largely to consuming bulky meals consisting of considerable volumes of porridgy cereal dishes much of which demonstrably passes undigested—a contrast to the habits of the dominant races noted. The greater aliveness of the latter is no doubt largely due to their better diet in which, apart from a better carbohydrate and protein balance, the herdsman benefits in receiving from his beasts in compact balanced forms all these necessary elements which they in their grazing have concentrated from areas far wider than those of the vegetarian's small fields.

The writer has in mind the more settled cultivating peoples in the Sudan. While they are likeable folk of charming manners and noble sentiments, and can be trained into fine soldiers of notable fortitude, yet as workmen or cultivators they are not the match say of the East Indian ryot or of the West Indian labourer. They share an understandable disinclination towards hard steady labour of the unexciting sort in a trying climate. In physical stamina they are definitely inferior, and in comparison are very inert mentally ; lacking in initiative or drive they are hard to interest or to teach. Prior to the last thirty years or so they have lived in very troublous insecure conditions. It is not yet possible to assess the various factors contributing to their shortcomings as units in a more civilised state. In part racial difference, in part the lack of an education, a tradition, and a social structure adapted to a secure peaceful cultivating existence in plenty are responsible, but the writer is strongly of opinion that an unsuitable diet is largely to blame. They suffer much loss of efficiency from minor ailments especially at the change of seasons, and a number of serious diseases are endemic with a consequent lowering of the general vitality. It is not suggested that these are acute diet-deficiency diseases, yet consideration of their diet reveals much room for improvement. It is a platitude that disease must be attacked from three angles—the agent, the means of spread, and deficiencies or defects predisposing the subject to succumb to the ill. Diet improvement by raising stamina and decreasing such predisposing weaknesses might well lead to large decreases in degree and in numbers, attacked. It has often been remarked how strikingly the growth physique bearing and alertness of native lads improves during their first year as boarding pupils in the training schools where the carefully regulated and ample diet is undoubtedly a large factor.

Among the wealthier, the educated, and the skilled artizan classes native diet is perhaps more or less satisfactory. Wheaten bread largely replaces *kisra* (an unleavened damper-cake of rough-ground millet flour akin to the Indian chupatty in type). Meat is eaten several times a week if not daily, occasionally eggs, poultry and fruit appear, in fact a richer and more varied diet.

Among cultivating villagers and labourers, beyond the usual *kisra*, meals consist of cooked vegetable preparations in variety. These are mostly cooked by prolonged stewing according to a definite native cuisine which varies according to the time of year. Certain herbs and certain dishes come only in certain months, such a potherb goes acceptably with meat while another not, although to the European there is a monotonous stewy sameness about them all. To a foundation of durra (or sometimes imported polished rice) are added in the stewpot sundry pulses, onions, native potherbs (usually of rank or bitter flavour), flesh or fish when available, each according to their proper recipes, seasons and proportions. They are always strongly seasoned from a variety of crude spices and condiments and are in a cruder African way kindred to the curries of the East. Once or at most twice a week does the villager eat meat, eggs seldom, fish hardly ever. A few redeeming features to which perhaps the Sudani may well attribute his freedom from actual deficiency diseases are the following. The mixed and commonly adulterated milks of goat, ewe, ass, cow and camel, are drunk as far as surplus to the needs of the young animals. Rank liquid butter and rendered animal tallow are reckoned the equivalent of the local vegetable oil (sesame) and to some extent interchanged with it in cookery, depending on the relative prices. The favourite and dominant seasoning always generously used is the locally produced cayenne pepper (*capsicum minimum* and *c. frutescens*). This spice is found a notable efficaceous adjunct to vitamin-deficient winter and forcing rations for poultry : perhaps another unconscious realisation by the native of his diet's shortcomings. Tomatoes and groundnuts in season, generally cooked, enter some of these recipes, and sour green limes eaten raw or as sugary lemonades are much liked when available, as also *merissa*, the local fermented millet liquor.

While it may be that with spread of enlightenment and higher standards of living this diet will adjust itself, yet the native is not aware of room for improvement other than quantitatively. He may buy more meat when well-off, but he has a strict sense of frugality and of the relative values he attaches to the various satisfactions purchasable with his cash. Let meat, as in the prosperous years before 1929, rise in price, or wages fall in relation, and the extra meat is the first "luxury" to be economised as those "necessities" sugar, tea and coffee are the last. For the better educability, health, and labour-efficiency of the native there was ample reason for looking into the possibilities of fish. If some balancing food could be made generally available, cheap and plentiful, and adaptable to the native cuisine and palate, not only could one improve the poor man's diet but perhaps start native industries and traffics in the produce such as might help to increase internal trade between the villages. The high repute of fish in European diets as a source not only of proteins but of other elements for which it is preferable to meat is well known. Sudan rivers and the Red Sea teem in their seasons with a multitude and a variety of fish as the corresponding abundance of various fish-eating birds which are such a marked feature of Sudan watersides well proclaims.

In the Sudan fish is little eaten and then only in the bigger towns, and waterside villages. Firstly the long distances and the climate make transport of this perishable a costly problem, capable of only very limited solution by natives. There is a social prejudice against fish-eating: among tribes, especially those with rather more Arab blood in their mixture and deriving from inland districts, where fish is seldom if ever on sale, and thus is an unfamiliar food considered as a rather inferior meat substitute—hardly a food for a gentleman, and every Sudani is *hidalgo* in his own eyes. When folk from such tribes settle in towns or on the river their prejudice is lost but slowly, thus in over half the riverside villages is found no fisherman, or none with a throw-net, leave alone a long-net.

Fish Preserving.

Enquiry revealed but two limited enterprises in fish preserving in operation in the country. A few boats sail from Omdurman up the White Nile to seine-net small fish, mostly under ten inches length, in some small quantity. These are crudely pickled ungutted in strong capsicum-spiced brine in empty petrol tins, and are so eaten in Omdurman where they meet with the approval of some elements in the mixed population of that polyglot congeries from most North and Central African tribes. This rank product cannot be eaten without ill-effects by all natives even, and is definitely unwholesome with a disgusting incipiently putrescent odour. Only about four of the many species of fish are suitable.

Secondly for a few days or weeks each summer, just as the earliest flood-water comes down, the Atbara river at its junction with the Nile teems with sardine-sized small-fry mostly of various species of the carp family. These are netted out in bulk, similarly pickled in petrol tins, soldered down and shipped quickly to Upper Egypt, where they meet a ready market at good prices. Neither of these products goes really well in the Sudan, one cogent reason being that only a town merchant with a big trade can be sure to sell out a 4-gallon tinful quickly enough to avoid heavy losses by putrefaction. There is also occasionally sporadic local traffic in sun-dried fish, mostly occurring where pilgrims of Nigerian origin have settled. This product has less odour, is not offensive to the native palate but is still hardly wholesome. During the course of these experiments one discovered, also among the Nigerians, some who knew and had at times practised a rough-and-ready method of curing fish in the smoke of wet wood fires under the cover of dense bushes.

The writer took opportunity three years running, in the local seasons of plentiful fish, to experiment in the dry curing of Nile fish. All the species regularly available were tried out and all can be excellently preserved by the methods to be described. Discussion of the species is omitted as probably of but limited general interest. In general, species of active predatory habits gave a better product than vegetable feeders such as the carp tribe. Large specimens of some of that tribe were suited for curing only if for consumption within ten days, as they oozed and dripped with rank fat in the curing and their flesh was left crumbling and soft, and was attacked by a species of beetle. *Tilapia*, an order widespread through Africa was of the best with its firm white perch-like flesh. Vegetable feeders lost more weight both in gutting and in drying than the predators.

The first curing shed was a small low windowless cubical mud hut having a flat roof of corrugated iron, a close-fitting door, and all crevices well plastered with mud. This worked quite well, but the second model gave better control, a better product, and a larger output for fuel and labour. It was a much higher walled hut, square, windowless and with roof as before, but a ventilator at the top of the back wall. The fire should be hot during the early stages to accelerate drying while the open ventilator discharges the steamy vapours. When the fish are superficially dry and rustle like dead leaves when shaken, the fire is slowed down, smoke increased, and the ventilator closed. Smoke production was a problem, as sawdust in quantity was not at first available. After several attempts a suitable burner was produced from an oil-drum, a sort of incinerator with a lid, and with the minimum of air holes beneath and at the sides designed by restricting air to produce a long smothered combustion. This was packed tightly with short billets of hard acacia wood having a bed of hot coals below. Later acacia sawdust became available, so that the usual bloater-curer's

fire could be adopted. About half a bushel of sawdust is made into a thick bed on the floor, a hardwood fire is kindled upon it and fed till a good bed of red coals is produced upon the sawdust, which emits a fair smoke the while. When the ventilator is closed the sawdust is raked together about and upon the hot coals, and then smoulders with a dense smoke for a day or more.

The preparation varies with the sort and size of the fish. Straight from the nets they are sorted for size and kind. Those having thick objectionable scales are quickly stripped of them. For a really wholesome non-perishable product the fish or slices of fish must nowhere exceed 1-inch in thickness. Small fry under seven inches need not be cut at all, above this length they must be slit ventrally, gutted and opened flat like a kipper. If even so the flesh would be too thick the larger fish must be filleted into three, the slice off each side, and the middle piece. At first the heads were removed as offal, but as the natives protested, holding the head a particularly desirable part of fishes, this was stopped. They are not particular as to the removal of entrails either, but for all fish over seven inches and for all the carp tribe over four inches, this must be done, otherwise the keeping qualities are impaired.

The cleaned and cut fish are washed, drained, sprinkled generously in heaps with crude sea-salt, and turned to spread it. Really small fry are then spread in a layer on fine meshed wire screens, larger specimens are threaded through the gills (bloater-fashion) or impaled 10 or 12 to a wooden spit a yard long. The curing shed is fitted inside with stout wires stretched in pairs upon which the spits, and screens full of fish, are laid in tiers, as many as the height of the shed permits, and smoking commences.

The tiny fry are finished in 6 to 12 hours at a bright golden colour, but the larger fish require 24 to 48 hours according to sort and size, and should be dried stick-hard to a deep tan colour. On removal from the sheds the trays and spits are best hung across wires in the open to dry further in sun and wind for a day or two before packing. Packing is simple in sacks, baskets boxes or bundles. The only trouble is the brittleness of the dried product, so that unless closely packed the fishes arrive looking somewhat battered and crumbled. The final weight is about one-third of the original weight of raw uncleaned fish, so that it is a light and bulky product. On soaking in water overnight, a desirable prelude to most methods of cooking it, it swells to almost its former weight and volume.

The problems of perishability in transport, of storage, and of the retailer of small turnover are thus solved. The product has been kept by the writer exposed to the air on shelves for over a year without deterioration. To the European nostril it is as a rather rank kipper in odour, but non-putrescent and wholesome. The native finds the odour unaccustomed rather than unpleasant, and will need repeated opportunities to accustom himself and to develop a taste for it. The writer has eaten freely of the product, which is wholesome and not unpleasant, although being highly cured to store well in Sudan temperatures, and to tickle the native palate, is too heavily salted and smoked to be really congenial to the European taste.

Samples were sent all over the country and a number of trials held locally with the assistance of native friends of all classes. With their aid a number of varied ways of incorporating it into the native cookery were devised and tried, several meeting with high approval from the *gourmets*. Reports on samples sent to the provinces were not enthusiastic, generally it would appear, because instructions for cooking were not carefully followed and the new flavour strange to the natives. Meat it was remarked was at present very cheap in the provinces.

The economics of production were carefully gone into and percentage losses at all stages recorded. The major item of cost is the price of the raw fish. At present, owing to limited native demand for fresh fish, there is but little fishing and that by poor primitive methods. Hence, when one demands a quantity for curing one strains the supply and runs up the prices which were anyway too dear in view of the abundance of fish in the waters. Thus in spite of plentiful fish, in absence of a large and assured demand, there are not yet the fishermen and efficient gear necessary to produce adequate quantities of fish at a reasonably cheap price. Before such a trade can be started then, active financial assistance will be needed as few natives have the capital, foresight, or capacity to embark on a long-range development of this sort. Then unless this is provided by the government, unlikely under present financial conditions, this possibility is hardly likely to develop quickly. Several trial orders for comparatively large lots to be shipped to mines in the Congo have been obtained through the active cooperation and assistance of the department concerned, and enterprising natives have been trained to these methods and set as contractors to supply these orders. This, however promising, was hardly the primary aim of the project, but it may in time familiarise the product and start the rudiments of an intra-Sudan traffic. Really to start such a traffic, attacks from two points with adequate financial backing are needed: firstly the anti-fish prejudice should be dissolved by propaganda and by the generous and *persistent* issue of free samples to allow the market to acquire the taste for kippered fish: secondly since fish is now considered only as a substitute for meat, until it is relished and required as an *addition* to the diet it must be able to compete with meat. This it can best do if it is excessively cheaper than meat, which it well could be if fishing methods were more efficient. The introduction and financing of adequate, properly rigged nets and instruction in their use, would enable fishermen to make large catches in these rich waters so that the raw material could easily be cheapened by as

much as 50 per cent. At that price, 1 lb. of dried fish (corresponding to 3 lb. of wet fish) could be sold between ½d. and ¾d. as compared with meat at about 2¼d. per lb. in the provincial markets.

This method was also tried out by the writer and others under his instruction on the Red Sea fishes. A really excellent product resulted, but for the same reasons it has not yet "caught on".

SUDAN FODDER GRASSES.

In connection with the examination of fodder grasses from Kordofan, Kassala, Darfur and White Nile Provinces during the past few years a few points of interest have arisen.

1. The fodder grasses as regards content of mineral matter are poor as a whole when compared with good pastures in Europe.
2. The most striking deficiency is nitrogen (protein), the average content being only 40 per cent. of a good natural pasture.
3. The average phosphorus content is also low, being about 50 per cent. of a good natural pasture. This is rather higher than the quoted figures for districts in Europe, Scotland and Australia where deficiency diseases occur from lack of phosphate, and appreciably higher than in South Africa and Kenya.

Pica* has only been reported to us from the White Nile Province; it is interesting, therefore, to note that all the homra or ghabash grass examined from this province shows a marked deficiency in phosphate.

Several other samples from other districts are low in phosphate, but no report of pica or definite diseases has been noted.

It has to be remembered that mixed grasses may be consumed.

4. In view of the lowness of phosphate content it would be interesting to know whether this indicates a lack of phosphate in the soil—as is the case in South Africa and Kenya where deficiency diseases due to lack of phosphate are well-known.

Comparing the ratio of nitrogen to phosphate in the samples from this country with the ratios for phosphate deficient grasses in South Africa, and with the ratios for good pastures in Europe, it is interesting to find that, as a whole, the ratios with Sudan grasses are rather lower than those with good pastures and very much lower than for South African grasses. This indicates that lack of nitrogen in the soil is the controlling factor in this country, a conclusion which agrees with the well-known lack of nitrogen in many arid soils. —(Quotation from 1931 Report of Government Chemist, Wellcome Tropical Research Laboratories, Khartoum, *Chem. Sect. Pub. No.* 65, *section* 12. *See* articles on The Place of Fisheries Work in The Tropics and on Fish Preserving Experiments on pp. 29-30 of this issue.)

* Deficiency disease of cattle.

"BIOLOGICAL" MANURES.*

[*Reproduced below is a summary of a paper on the relationships of organic fertilisers and vitamins read by Mr. R. D. Anstead at a meeting of the Planters' Group of the Royal Empire Society which was held recently in London. This summary, cyclostyled by the Imperial Bureau of Soil Science as monthly letter No.* 38 *is a report and discussion of the lecture and was prepared by Dr. Hugh Nicol of the Bacteriology Department at Rothamsted. The question of the relative merits of organic and inorganic manures is coming very much to the fore in connection with the reviving interest in the improvement of crop quality rather than quantity and in this connection it is believed that the following notes will be of interest.* ED.]

Mr. Anstead stated that the value of fertilisers had hitherto been judged by their effect upon crop yield. An ideal manure should, however, promote disease-resistance in the plant and should maintain "quality" in the crop. By "quality" he implied nutritional value, expressed not in calories but in terms of the content of vitamins. A diet, adequate in all respects, was easily obtained by a middle-class inhabitant of Britain, and the likelihood of nutritional deficiency was not there a serious problem. Such a problem might, nevertheless, arise as a consequence of an ill-thought out plan of increasing home agricultural production by an intensive use of artificial fertilisers. In tropical countries, however, where natives relied entirely upon a few staple articles of diet, a diminution of the vitamin content of even one food stuff might be attended by grave consequences. The lecturer did not deprecate the use of artificials in conjunction with cattle-dung or other organic manures, but he claimed that only organic manures could ensure a crop of high vitamin content.

Mr. Anstead indeed opened his lecture by saying that he might claim the beginning of "manuring for quality" to have been made in the Madras Presidency while he was Director of Agriculture. At Coimbatore, there is a series of permanent manurial plots receiving no manure, cattle manure and various combinations of artificials. It was noticed that when grain harvested from each plot separately was sown on ordinary land, marked differences resulted in the ensuing crops. Grain harvested from the cattle-manure plot gave higher germination, a thicker stand, and a better crop than did seed from an unmanured plot or from a plot manured with artificials. In short, seed from the cattle-manure plot was the most vigorous.

Further investigations by Dr. R. McCarrison showed that the nutritional value (tested on animals) of the differently manured grains varied considerably. Grain from the cattle manure plot had its full complement of vitamins, while the other samples which had not been grown with dung were deficient in vitamins.

* *See* also *Tropical Agriculture*, Vol. XI, No. 3, pp. 69-73.

Mr. Anstead suggested that a great part was played by the micro-organisms of animal manure in producing the accessory substances necessary for vitamin formation in the crop.

He suggested that some micro-organisms in animal manures synthesize vitamins, the plant being, apparently, unable to form them for itself, since if organic manure is withheld the plant does not contain them.

The question is complicated by the popular confusion which exists between the terms "hormone", "vitamin", "auximone", "auxin", "accessory growth-promoting substances", &c. Animal hormones are quite distinct from vitamins, which appear to be synthesized only by plants and are utilized as growth-promoting substances by animals. Vitamin A may be produced in the animal from carotene, a plant product. "Auxin" is actually the plant hormone controlling the growth of young shoots. None of these terms covers the hypothetical plant-growth-promoting substance—for which the name "phytamin" is suggested—which is assumed to occur in organic manures. It would indeed be remarkable if true vitamins (*i.e.*, those plant products required by animals for their growth) were also substances essential for plant growth. If "phytamins" and vitamins are identical, it follows that the plant, by mere growth, is able to produce its own growth-producing factors. *A priori*, this does not seem reasonable. It seems more likely that the true vitamins are hormones in plants—*i.e.*, they control metabolism and regulate growth-processes but do not initiate them. A distinction between vitamins (plant hormones) and "phytamins" seems to be as necessary as the evident distinction between animal hormones and vitamins.

A. I. Virtanen *et al* (*Ann. Acad. Sci.* Fenn., Ser. A, 1933, Vol. 38, No. 7) have followed the course of production of vitamin C and of carotene in peas and wheat grown under ordinary and sterile conditions in sand with only inorganic salts. Since the previous manurial history of the seeds was not given, it is not possible to say how far these experiemnts support or deny Mr. Anstead's theory that vitamins must be supplied from outside. A precursor of vitamin C may have been already present in the seeds. Biological and chemical tests agree in showing that many *seeds* contain little or no vitamin C which, however, is rapidly developed after germination has begun. S. N. Ray (*Biochem. Journ.* 1934, 28, 996) has examined the rate of production of vitamin C in seedlings, but he could not determine the nature of its precursor.

It is, however, conceivable that the hypothetical "phytamins" of organic manures are derived from hormones excreted by animals—urine is known to contain at least one vitamin (C) as well as several animal hormones. Schoeller and Goebel (*Biochem. Ztschr.* 1931, quoted by Nemilov in *Bull. Appl. Bot. Gen. and Plant Breeding*, Leningrad, Nos. 5-6) obtained marked stimulation of growth, blossoming and fruiting of hyacinths and tomatoes by the use of the female sex hormone. Butenandt and Jakoby (quoted in *Madras Agric. Journ.* 1934, 22, 287) have found in palm nuts a substance apparently identical with a female sex hormone (occurring in animals). If this be so, it would appear either that the substance is normally indestructible and circulates continually from animal to plant and back again, or that it is continually being re-formed from some precursor. This precursor in the case of plants may well be a "phytamin" resulting from microbial activity in organic manures. The evidence is admittedly inconclusive, but the suggestion it offers of a cycle or transformation of "phytamins", vitamins and hormones circulating from the soil to the plant and animal and back to the soil, is attractive, and would afford quite a satisfactory explanation of the superior manurial value of farmyard manure over artificials.

The Rothamsted experiments have not borne upon the nutritional quality of crops, but baking tests have shown that both Rothamsted and Woburn "continuous" wheats, however manured, all produce a very poor loaf, there being no apparent correlation between manuring and baking quality. Baking quality is a man-made quality, which may have no relation to the natural vigour of the crop. Rothamsted not being a general farm, the animals which produce manure for the "classical" plots are mostly castrated males. This point does not seem to have been appreciated before, but it may be significant in this connexion. A possible rôle of leguminous crops has also been suggested (Nicol, *Biol. Rev.* 1934, 9, 383). Rothamsted "continuous" clover has become difficult to maintain on garden soil originally richly manured, hence it looks as if dung alone is not enough and there may be a specific value in rotation. The unexplained effect observed by Hartley and Greenwood (*Emp. J. Agric. Sci.* 1933, 1, p. 133) of small applications of farmyard manure in Nigeria adds support to the biological theory. Similarly, in the discussion of Mr. Anstead's lecture, Dr. H. E. Tempany referred to an area in Malaya which after a period of generous dosage with "complete" artificial, absolutely failed to yield an annual crop (maize) until dung had been applied. This he had noted not once but repeatedly.

This extreme case does indeed suggest that there is some constituent in dung which is not evaluated by current chemical methods. It is rare for an entire crop to fail for lack of organic manure, but it is possible, and indeed probable, that a wider use of dung and compost would lead to healthier crops and lessen the incidence of pests. These effects of farmyard manure are widely recognized and fully justify a careful and unbiassed investigation of their cause.

GUMMOSIS OF CITRUS IN TRINIDAD.

II.—The Causal Organisms.

By R. E. D. Baker,
(*Department of Mycology, Imperial College of Tropical Agriculture.*)

1. Introduction.

Although gummosis diseases of citrus have been known for close on a hundred years, it is only within the last twenty-five that the organisms causing these diseases have been isolated and identified. Two of the commonest are *Phytophthora citrophthora* (Sm. and Sm.) Leon. and *Phytophthora parasitica* Dastur. One or other or both are found practically wherever citrus is grown.

Taxonomy in the genus *Phytophthora* de Bary, is generally recognised as presenting serious difficulties: although a discussion of this subject is beyond the scope of this article a brief account of nomenclature relevant to gummosis will be given to facilitate the study of cognate literature.

In 1906 R. E. and E. H. Smith (1) isolated a fungus from lemon fruits attacked by brown rot; the organism, *Pythiacystis citrophthora* Sm. and Sm., was considered to be sufficiently removed from both *Pythium* and *Phytophthora* to be placed in a new genus. In 1912 Fawcett (2) demonstrated that this fungus was also responsible for gummosis of orange trees in California. Shortly afterwards he isolated another species of *Phytophthora*, later identified in 1917 by Sherbakoff (4) as *Phytophthora terrestria* Sherb., from orange trees in Florida. This nomenclature, however, was soon superceded. Leonian's (5) examination of *Pythiacystis citrophthora* convinced him that it was unquestionably a member of the genus *Phytophthora*: in consequence, he regarded the genus *Pythiacystis*, of which *Pythiacystis citrophthora* was the only representative, as untenable, and renamed the parasite *Phytophthora citrophthora* (Sm. and Sm.) Leon. This name is now generally accepted.

Meanwhile Dastur (6) in India (1913) had described a fungus attacking castor oil plants which he named *Phytophthora parasitica* Dastur. Sherbakoff's *Phytophthora terrestria* was shown by Butler (7) to be identical with this fungus, and since Dastur's description has priority, *Phytophthora terrestria* Sherb. must be regarded as a synonym of *Phytophthora parasitica* Dastur. *Phytophthora parasitica* Dastur. has a wide distribution and in its various biologic forms causes many plant diseases other than citrus gummosis. It is closely allied to *Phytophthora citrophthora* (Sm. and Sm.) Leon. but is regarded as a distinct species by Tucker (8), in his recent monograph. It will be seen in the present paper that it is chiefly responsible for citrus gummosis in Trinidad. *Phytophthora citrophthora* has not yet been found in the colony.

It has recently been shown that certain strains of *Phytophthora palmivora*, the causal organism of black pod and canker of cacao and bud rot of coconuts, are able to cause both gummosis and fruit rot of citrus. Hitherto comparatively little has been known about this subject, but in this article it will be shown that there is a "Trinidad" strain of *Phytophthora palmivora* which can cause both diseases in 'Marsh' grapefruit, and further that although this strain has been identified on morphological and cultural grounds as a member of the 'cacao group' it is incapable of causing 'black-pod' disease of cacao. It is therefore not the same strain as the one which attacks cacao in Trinidad.

2. Symptoms.

Gummosis disease, caused by *Phytophthora parasitica* on citrus trees in California and elsewhere has been fully described by Fawcett (3). The symptoms of the disease on 'Marsh' grapefruit trees in Trinidad are in close agreement with his description. In Trinidad the majority of grapefruit trees are budded on sour orange stock which is resistant to gummosis. In the earlier plantings (*i.e.* in the case of the older trees) budding was frequently effected too low (9); it is on the susceptible grapefruit scion just above the bud union that trees are most commonly attacked (Figs. 1 and 2). During the early stages of the disease the foliage and fruit remain unaffected and it is only by careful examination of the trunk that the disease can be detected. If an attack of gummosis is suspected and the surface of the bark is slightly scraped, the diseased tissues will be found to be brown while the healthy tissues are greenish-yellow in colour. The diseased tissues are not sharply delimited, the brown area fading gradually into the green. At a later stage the diseased bark becomes slightly sunken and cracked longitudinally, and usually gum begins to exude from these cracks. The appearance of gum is not always a reliable symptom of the disease, it may flow freely early in the attack, or just a few drops may exude at a late stage and in a few instances no exudation of gum has been observed at all. In a normal tree the production of gum is a response to wounding of the bark irrespective of whether this is done by insects, fungi or mechanical means. The amount produced probably depends on the season and on the physiological condition of the tree at the time but the precise factors involved have not been determined. If the bark is removed from a diseased area a dark brown stain will be observed in the cambium and on the exposed surface of the wood (Figs. 2 and 3). This brown stain affords a ready means of diagnosing gummosis: it is always present even when there has been no exudation of gum. It is also a useful indication of the area of the bark involved, and in control work bark must

be removed until clean wood can be seen all round the stained area. In the cambium the stained area is often surrounded by a definite yellow ring, which, being uninfected, need not be removed. When the bark is removed there is generally a copious flow of gum from the cambial region of a lesion. This is explained by the fact that gum is held under pressure in this region until it is liberated subsequent to the formation of cracks in the bark.

No symptoms are present in the foliage until the attack is far advanced and the tree is practically ring-barked by the disease. When this stage has been reached the leaves turn yellow and later begin to fall. The tree comes into flower irrespective of season and a heavy crop of small fruit is set. Heavily infected trees can be singled out by their yellow foliage and unhealthy appearance from a distance of several hundred yards. Unless remedial measures have been instituted before this stage is reached they are almost valueless, and the trees generally die within a year.

Symptoms on other citrus species and varieties are essentially similar to the above, except that in susceptible varieties grown as seedlings, *e.g.*, sweet oranges (*C. sinensis*) and tangerine oranges (*C. nobilis*), the attack is often lower down, thus giving the appearance of a 'foot-rot' or 'collar-rot.' Many names have been used for such diseases (including gummosis, root-rot, collar-rot, foot-rot, collar-canker, bark-rot and mal-di-gomma) the descriptive title depending more on the position of the attack than on the organism involved. In the writer's opinion the most appropriate term is gummosis, coupled with the name of the parasite and the variety attacked. (In much of the literature 'gummosis' is coupled with *Phytophthora citrophthora*, and 'mal-di-gomma' with *Phytophthora parasitica*).

3. Isolation.

During the wet season of the year 1934 isolations of species of *Phytophthora* were repeatedly obtained in pure culture from the bark of 'Marsh' grapefruit and other citrus trees. The method used was as follows:—bark stripped from diseased trees was brought back to the laboratory with as little delay as possible in large specimen tubes. Small pieces from the inside of these strips were plated out on plain agar in Petri dishes, eight pieces per dish. Various other media including potato agar, malt extract agar and corn meal agar were tried, but it was found that these media were too rapidly contaminated, and that plain agar was the most satisfactory. After two or three days the Petri dishes were examined and any colonies of *Phytophthora* spp. which had developed were sub-cultured on to potato agar slopes. All stock cultures were kept on potato agar slopes or potato blocks, both of which gave satisfactory results. It was observed that the organisms, when growing out from pieces of bark on plain agar, readily produced sporangia in two or three days, and also that their coenocytic mycelium formed characteristic irregular colonies, thus rendering identification easy at low magnifications. The percentage of isolations obtained was generally low, being of the order of 10 per cent. or 20 per cent. of the total platings made; experience indicated the advisability of making at least 50 platings from each tree, a procedure which generally yielded six to ten cultures of the organism. In all, over two thousand platings were made from thirty 'Marsh' grapefruit and various other citrus trees growing on eight estates in different parts of the island. The following cultures were obtained:—

Phytophthora species	.... 278 cultures
Other fungi	.... 314 do.
Blanks or secondary bacteria	1,493

A characterisitc culture from each tree was given a serial number and kept for comparison in order to determine whether one or more species of Phytophthora was responsible for gummosis in Trinidad. Isolations from 'Marsh' grapefruit trees were numbered A1, A2, A3, &c., and isolations of *Phytophthora* species from any other source, whether gummosis or fruit rot, were numbered B1, B2, B3, &c. Twenty-one isolations were obtained in the 'A' series from 'Marsh' grapefruit trees on seven different estates, situated in all the chief grapefruit producing areas of the island. The eighteen isolations in the 'B' series included cultures from gummosis lesions on Washington navel orange (*Citrus sinensis*), rough lemon (*C. Limonia*), sour orange (*C. aurantium*), *Citrus hystrix* and sweet lime (*Citrus* sp.) trees growing on four different estates.

According to Fawcett, the occurrence of live mycelium of *Phytophthora citrophthora* in citrus bark is somewhat erratic under Californian conditions, since it lives only in the outside centimetre or two of an actively expanding gummosis lesion, and is liable to die out completely under unfavourable weather conditions. This was also found to be true for *Phytophthora parasitica* in Trinidad. During the long severe dry season of 1934 repeated attempts were made to isolate the fungus but without success. In addition many cases were observed in the field where the fungus had apparently died out and the lesions had ceased to advance. In such instances the wounds were healing rapidly and the trees were making a good natural recovery. Cultures of *Phytophthora* were readily obtained with the advent of the rains and the return of conditions favourable to the fungus. It appears therefore that under dry conditions in Trinidad *Phytophthora parasitica* ceases to advance through the bark of citrus trees and becomes severely attenuated in many lesions, especially on trees possessing some natural resistance, *e.g.*, the sour orange. It is able to attack the trees again as soon as the rains commence when conditions for its growth become more favourable. This behaviour on the part of the live mycelium probably explains the low percentage of isolations obtained, since there are difficulties in collecting diseased bark in precisely the right condition for culturing.

Three experiments were devised to determine the position in the bark most commonly occupied by the live mycelium. In the first, isolations were made from the inside of the bark (*i.e.*, the cambium), but from three different positions on the gummosis lesions; (1) from the junction of the healthy and diseased bark, (2) from a point one centimetre into the diseased bark, and (3) from the centre of the lesion. The results are shown in Table I :—

Table I.

Position of isolations.	Total.	Successful.	Percentage success.
1 At junction ..	616	122	20%
2 1. cm. into diseased tissue	160	11	7%
3 Centre of old lesion ..	132	0	0%

These differences are noteworthy, and are in complete agreement with Fawcett's statement that there is only a narrow ring of live mycelium of *Phytophthora* at the periphery of each lesion, and that only saprophytic fungi will be obtained from the older regions of the lesion.

In the second experiment, isolations were made from the inside of the bark at the junction of healthy and diseased tissues, but at (1) the top, (2) the bottom, and (3) the sides of the lesion (*see* Table II).

Table II.

Position of isolations.	Total.	Successful.	Percentage success.
1 Side of lesion ..	152	28	18%
2 Top of lesion ..	216	35	16%
3 Bottom of lesion ..	136	29	21%

There is no outstanding difference between these three sets of figures showing that the fungus spreads in all directions through the bark though not necessarily at a uniform speed. From the general shape of lesions it is evident that fungal advance takes place more rapidly in the vertical direction.

In the third experiment, isolations were made at the junction between healthy and diseased tissues, samples being taken from the inside of the bark (*i.e.*, in the cambium) and from the outside, just below the cork layer. The results are summarised in Table III.

Table III.

Position of isolations.	Total.	Successful.	Percentage success.
1 Inside of bark ..	624	113	18%
2 Outside of bark ..	136	22	16%

There is again no outstanding difference between the two results showing that the fungus occurs transversely through the diseased bark from cambium to cork.

The above experiments show that in an actively expanding lesion live mycelium of *Phytophthora parasitica* will be found through the bark in a ring one or two centimetres wide round the periphery of the lesion. It therefore follows that the best position from which to make isolations is the inside of the bark (thereby avoiding surface contaminations) at the junction of healthy and diseased tissues.

Several saprophytic fungi quickly follow the *Phytophthora*, and under certain conditions may become dominant. Of these fungi the commonest is *Fusarium lateritium*, Nees. var. *fructigenum* (Fries) Wr. n.c., which occurs so regularly that at one time it was considered as a possible cause of gummosis (*see* Section 6). *Botryodiplodia theobromae* and *Trichoderma lignorum* also occur but comparatively infrequently. If isolations are made at a distance of more than one centimetre into the diseased tissues, one or other of these fungi and not *Phytophthora parasitica* is almost invariably obtained. Attempts were also made to obtain cultures of *Phytophthora* spp. from rotten fruit, since both *Phytophthora citrophthora* and *Phytophthora parasitica* cause destructive fruit rots in other countries. Isolations were not obtained in the dry season, but as soon as the rains commenced, they were easily secured. Cultures of *Phytophthora parasitica* were repeatedly obtained from the fruits of the grapefruit, the West Indian Lime and *Citrus hystrix*: and in addition to these *Phytophthora palmivora* was obtained from grapefruit on various occasions both in the field and in the citrus packing shed. So far citrus fruit rots caused by *Phytophthora* species have not proved of any economic importance in Trinidad. The commonest fungi obtained from rotten fruit are *Botryodiplodia theobromae*, and *Penicillium* species. At a later stage in these investigations it was demonstrated by inoculation experiments that these strains of *Phytophthora parasitica* and *Phytophthora palmivora* are capable of producing rots of other fruits in addition to grapefruit.

4. Cultural Work with the Phytophthora Isolations.

Using the 39 isolations of *Phytophthora* described above the following experiments were undertaken to determine whether one or more species of *Phytophthora* was represented.

In preliminary experiments an attempt was made to find a synthetic medium suitable for cultural work on *Phytophthora* spp. In spite of the obvious drawbacks of a non-synthetic medium in work of this nature, potato sucrose agar proved superior to the various synthetic media and consequently was used as the substratum in the following experiments.

I. Using twenty-one isolations (A1 to A18 and B1 to B3) with five Petri dishes of each isolation, increases in colony diameter were measured every twenty-four hours. The cultures

were kept at a laboratory temperature of approximately 30°C and after five days mean growth rates were calculated (Table IV). Although these varied between 8.6 mms. and 11.6 mms. per twenty-four hour period the growth rates of the twenty-one isolations formed such a regularly increasing series (Table IV) from A14 to A18 with a mean growth rate for all of 10.4 mms. that it was impossible to differentiate between them. In general all the cultures appeared very similar to the naked eye ; some had more aerial mycelium than others, or more marked growth rings, but such differences were insignificant and could be attributed to the varying thickness of the medium.

Table IV.—Growth Rates in Culture.

Culture No.	Mean increase in diameter of colony in 24 hours.	Culture No.	Mean increase in diameter of colony in 24 hours.
A 14	8.6 mms.	A 11	10.6 mms.
A 3	8.8 ,,	A 17	10.8 ,,
B 2	9.0 ,,	A 2	11.0 ,,
A 4	9.2 ,,	A 16	11.0 ,,
A 1	9.6 ,,	B 1	11.0 ,,
A 6	9.8 ,,	A 9	11.2 ,,
A 12	10.0 ,,	A 10	11.2 ,,
A 13	10.2 ,,	A 8	11.4 ,,
B 3	10.2 ,,	A 15	11.4 ,,
A 5	10.4 ,,	A 18	11.6 ,,
A 7	10.4 ,,		

Mean of all 10.4 mms.

The above experiment was repeated with corroborative results. The inference to be drawn from these data is that although the several isolations are definitely referable to one species, slight but consistent differences in physiological characters are exhibited.

II. A further isolation (B5), obtained from a lesion of gummosis on a rough lemon tree, showed certain noteworthy differences from previous isolations. Accordingly its growth-rate was compared with the growth-rates of other isolations, with the results shown in Table V.

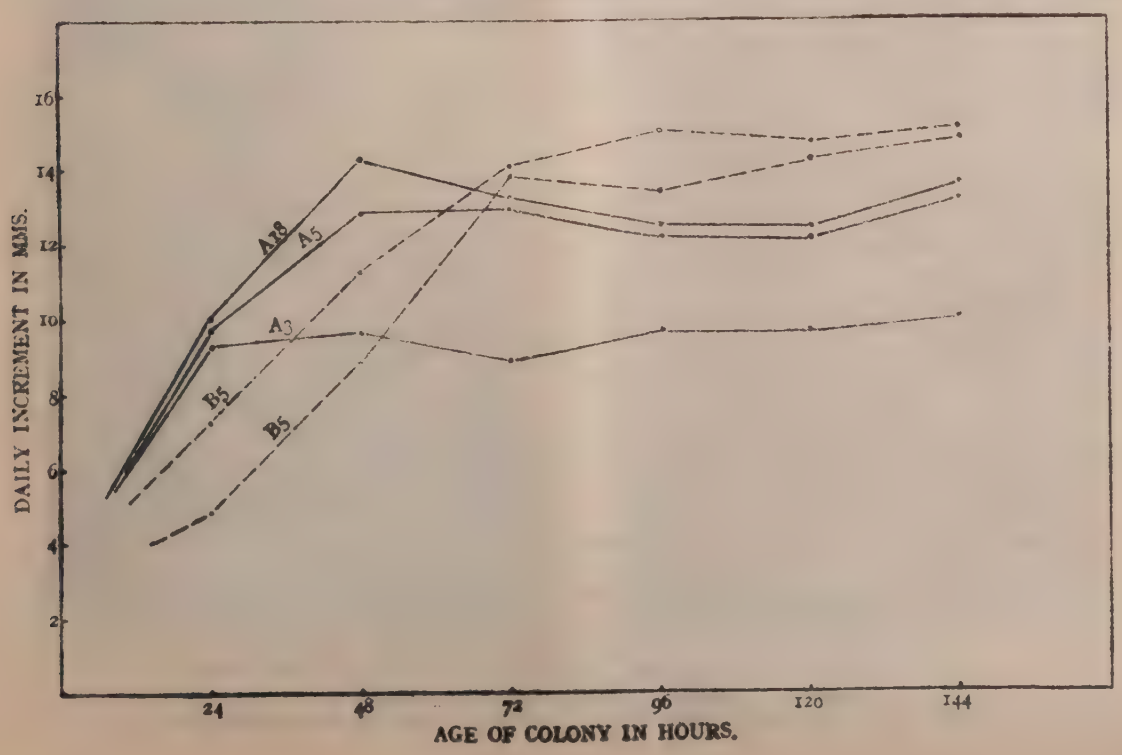
Table V.—Growth Rates in Culture.

Culture No.	Mean increase in diameter of colony in 24 hours.	Culture No.	Mean increase in diameter of colony in 24 hours.
A 3	10.0 mms.	A 7	12.6 mms.
A 4	10.6 ,,	A 18	13.1 ,,
A 5	12.5 ,,	A 8	13.3 ,,
		B 5	14.8 ,,

Mean of all except B5=12.0 mms. (extremes 10.0 and 13.3 mms.)
B5=14.8 mms.

In addition to the fact that B5 grew considerably faster than any of the other isolations, it also produced much less aerial mycelium ; and, unlike the other isolations, formed sporangia abundantly on potato agar. Text Fig. I, shows characteristic growth curves derived from another experiment, for B5 and other isolations.

TEXT FIG. 1.



It will be noted that B5 shows an initial lag, but later has a higher growth rate than the other isolations.

Measurements of sporangia were consistently taken, from which it was found that those of B5 differed somewhat from those of other isolations. In general the sporangia of B5 tended to be lemon-shaped, whereas those of the others could be described as pear-shaped (Fig. 5). The ratio of length to breadth of sporangia was consistently higher in B5. (*See* Table VI.)

Table VI.—Dimensions of Sporangia.

Strain No.	Culture medium.	Length in μ	Breadth in μ	Ratio.
B 5	plain agar	50 (41-60)	32 (26-38)	1.6
,,	,,	53 (41-64)	29 (23-38)	1,8
,,	potato agar	51 (45-60)	34 (30-38)	1.5
,,	,,	57 (49-68)	38 (34-45)	1.5
,,	grapefruit (rotten fruit)	50 (38-68)	32 (23-38)	1.6
Other A and B Strains	plain agar	47 (45-53)	38 (34-45)	1.3
,,	,,	43 (38-45)	35 (30-45)	1.2
,,	,,	50 (38-60)	39 (30-45)	1.3
A 21	,,	49 (45-53)	39 (34-45)	1.3

The zoospores of both vary in diameter from 7-13 μ

From these experiments it was evident that while the isolations B1 to B4 and A1 to A18 all belonged to the same species, B5 was sufficiently different as possibly to belong to another species. At a later stage in the investigations, isolations similar to B5 were frequently obtained from rotten grapefruit.

5. Identification of the Species.

Cultures of the two contrasted species described above were sent to the Imperial Mycological Institute for identification. The species most commonly isolated from gummosis trees and from brown rot of fruit has been identified as *Phytophthora parasitica* Dastur. and the other species as a strain of *Phytophthora palmivora* in the 'cacao' group. The latter identification is of especial interest since it is only recently that this organism, the common cause of 'black pod' disease and canker of cacao, has been proved to include strains responsible for gummosis and fruit rot of citrus in other countries.

6. Inoculation Experiments on 'Marsh' Grapefruit Trees.

Using pure cultures of *Fusarium lateritium* var *fructigenum*, *Phytophthora parasitica* and *Phytophthora palmivora*, inoculation experiments were devised to determine which were capable of causing gummosis of 'Marsh' grapefruit. For convenience grapefruit trees about four years old growing on the College estate were used. The technique of inoculation used throughout was as follows:—the trunk of the tree was first washed down with methylated spirit to effect superficial sterilisation. A small circular piece of bark was then removed with a ½ inch diameter cork-borer, mycelium from a young potato-agar culture was inserted into the wound, and the bark replaced. The wound was then covered with a pad of absorbent cotton wool and bound up with insulating tape (Fig. 4). Controls were made in an exactly similar fashion except that no inoculum was placed in the wound. The pads of cotton wool covering both inoculations and controls were moistened with distilled water once a day for a week to provide moist conditions in the wound and to allow the fungus to become established.

I. Fusarium lateritium, var. *fructigenum.*

Four inoculated, and four uninoculated wounds were made just above the bud union (*i.e.*, about a foot from the ground). After fifty-eight days the tapes were removed and the wounds examined. Both inoculated and control wounds were found to be practically healed over and no trace of gummosis had developed.

II. Phytophthora parasitica.

After thirty-six days four out of the five inoculated wounds showed typical incipient symptoms of gummosis, *i.e.*, a copious flow of gum, dead bark up to 3 cms. from the point of inoculation, and the typical dark brown stain on the wood under the dead bark. The controls, five in number, were healthy and had begun to heal over.

A second series of twenty-four inoculations (isolation A1) and eighteen controls was carried out on three 'Marsh' and one 'Corner's Prolific' grapefruit trees. Fourteen days later gum was observed exuding in large quantities from the inoculations, and in small quantities from some of the controls. It is obvious that since all the controls remained healthy for the duration of the experiment this gumming was simply a response to wounding and not to the attack of a parasite. After forty-eight days the eighteen controls had remained healthy whereas the twenty-four inoculations had developed typical gummosis. In the worst case 60 sq. cms. of bark around the point of inoculation were attacked (Figs. 6 & 7). Using isolation A3, confirmatory results were again obtained after 46 days.

The fungus was re-isolated from typical infections.

These experiments prove conclusively that *Phytophthora parasitica* is capable of causing gummosis of 'Marsh' grapefruit in Trinidad. Moreover since this fungus has been isolated from grapefruit trees in the field on many separate occasions (*see* Sect. 3) it may be accepted as a common cause of citrus gummosis.

GUMMOSIS OF CITRUS IN TRINIDAD.

II.—The Casual Organisms.

FIG. 1.—*Gummosis caused by Phytophthora parasitica at the bud union of a 'Marsh' grapefruit tree on sour orange stock.*

FIG. 2.—*The tree depicted in Fig. 1 with the diseased bark excised to show the dark brown stain on the wood.*

FIG. 3. *An attack of gummosis (Phytophthora parasitica) higher up a 'Marsh' grapefruit tree. Diseased bark excised to show the dark brown stain on wood.*

FIG. 4.—*Inoculation technique, on a four-year old tree.*

GUMMOSIS OF CITRUS IN TRINIDAD.

II.—The Casual Organisms.

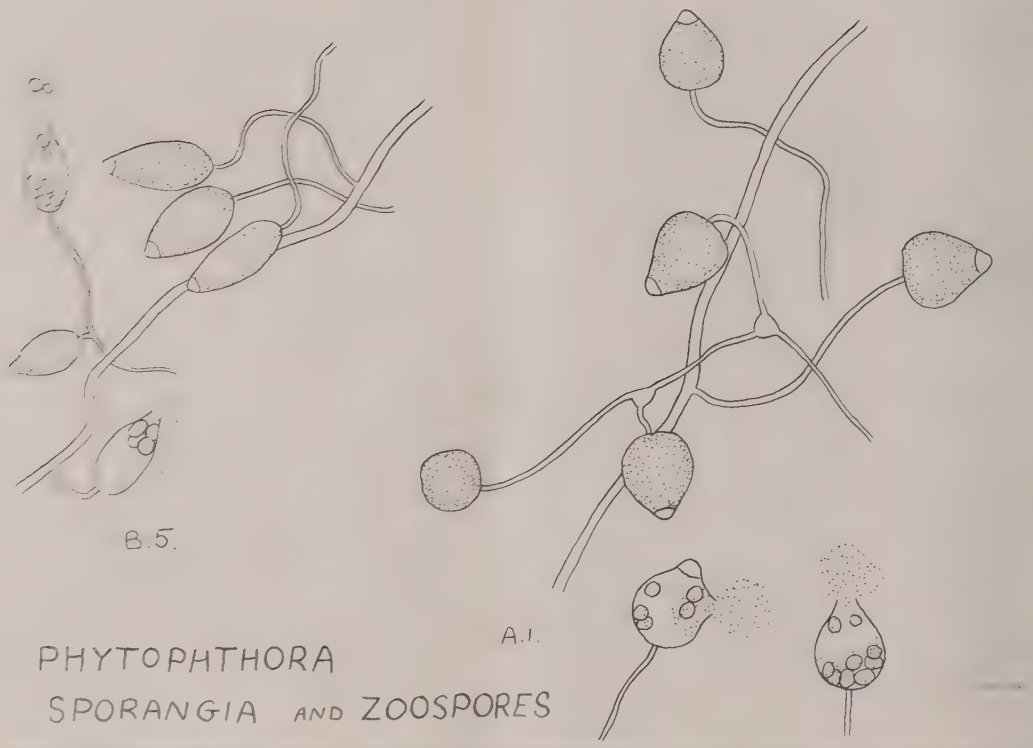


FIG. 5.—*Phytophthora parasitica* (*A*1) *and Phytophthora palmivora* (*B*5) *sporangia and zoospores.*

FIG. 6.—*Successful inoculations with Phytophthora parasitica X, inoculations.*

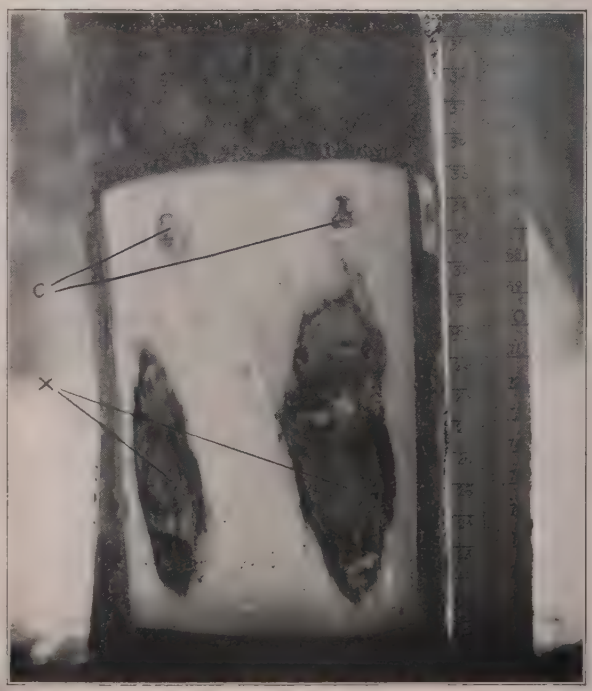


FIG. 7.—*Detail of Fig.* 6.

GUMMOSIS OF CITRUS IN TRINIDAD.
II.—The Casual Organisms.

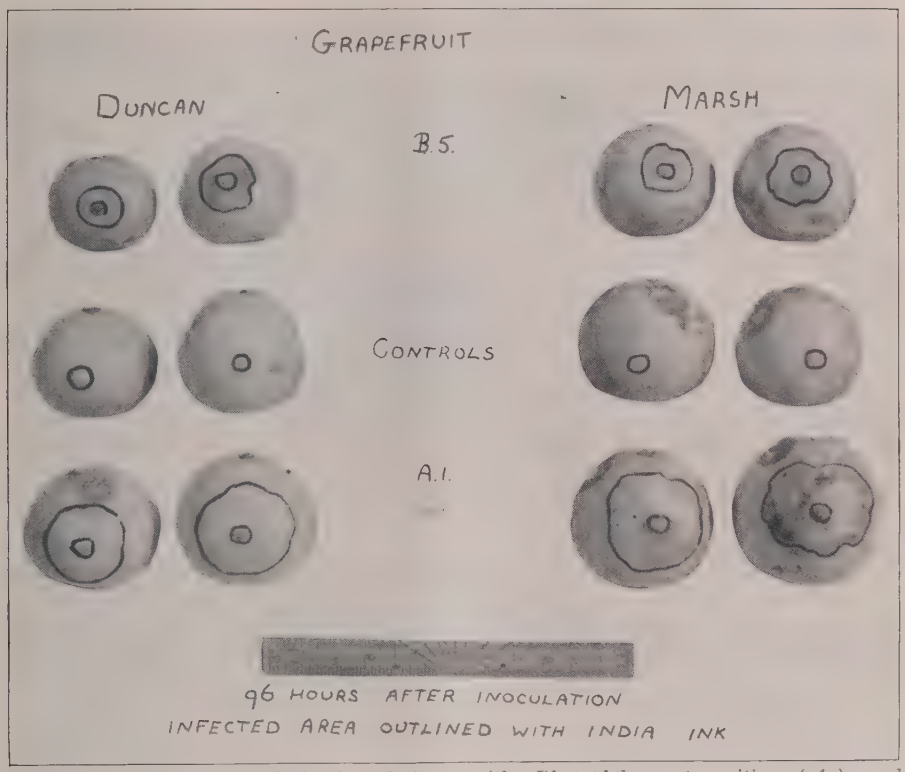


FIG. 8.—*Four-day old fruit inoculations with Phytophthora parasitica (A1) and Phytophthora palmivora (B5).*

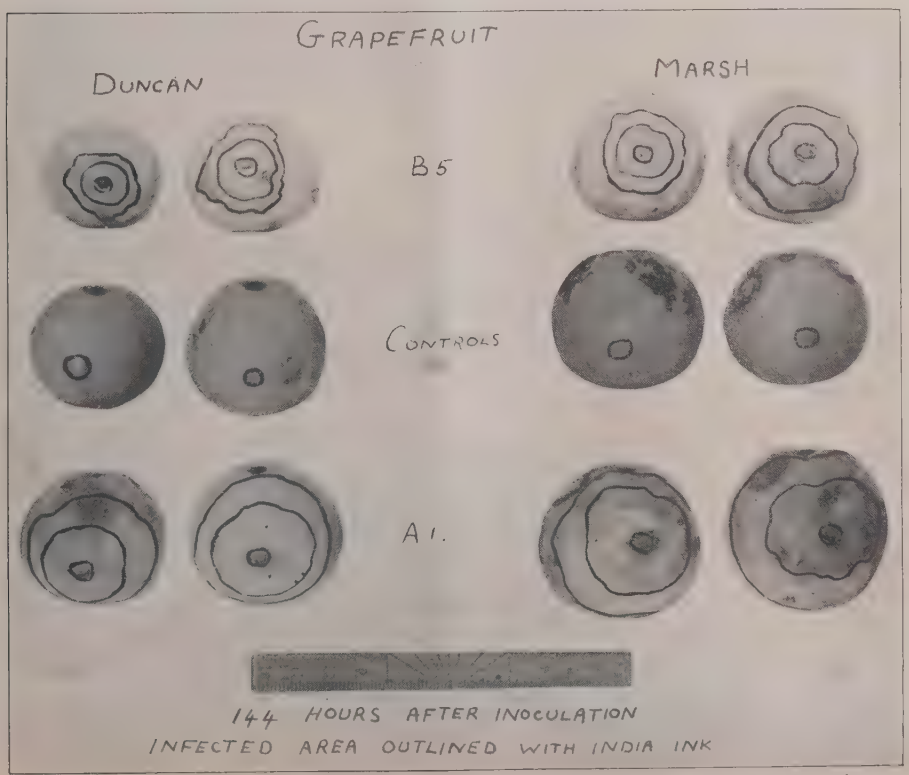


FIG. 9.—*The same fruit after six days, showing the rate of spread of the parasite.*

GUMMOSIS OF CITRUS IN TRINIDAD.

II.—The Casual Organisms.

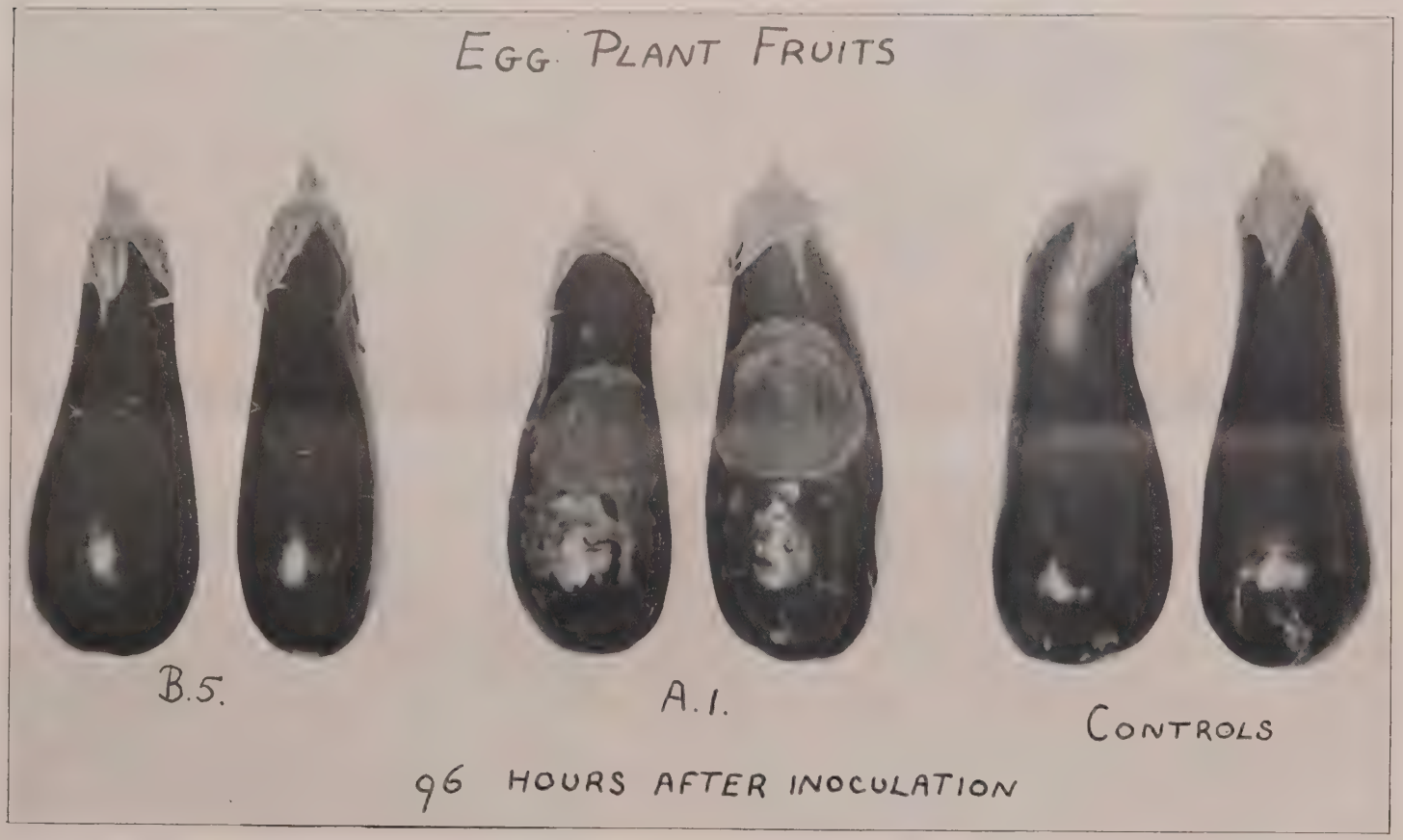


FIG. 10.—*Four-day old inoculations of eggplant fruit.*

III. Phytophthora palmivora.

After forty-four days using the B5 strain all of six inoculations were exuding large quantities of gum; on excising the diseased bark the affected regions were observed to vary in area from forty-six to ninety-nine square centimetres and that during this brief period the tree had been seriously damaged. The fungus was easily re-isolated from diseased bark. The three controls remained healthy.

This experiment demonstrated conclusively that under experimental conditions, *Phytophthora palmivora* is capable of causing gummosis of grapefruit trees in Trinidad just as readily as *Phytophthora parasitica.*

In these experiments, the infected tissues were removed and the wounds left to dry without further protective treatment. It was consistently observed that this simple treatment was quite effective, and that once the diseased bark has been removed, the trees, given suitable environmental conditions, grew abundant callus tissue and began to make a rapid recovery from the gummosis.

7. Inoculation of Fruits.

Since *Phytophthora* species are known to cause brown rots of lemons and other citrus fruits in other countries inoculations were made on fruits using the strains isolated from gummosis lesions. In the majority of these experiments both *Phytophthora parasitica* and *Phytophthora palmivora* were used.

The following technique was used throughout. The fruit was washed with methylated spirit, and small wounds inoculated with mycelium from a potato-agar culture. The fruits were then stored over water in desiccators. Omitting the inoculum, control fruits were treated in a similar fashion.

I. Grapefruit.

Both 'Marsh' and 'Duncan' varieties were successfully infected by both species of *Phytophthora,* a firm, leathery, slightly sunken light brown rot of the skin being produced (Figs. 8 & 9). All the controls remained healthy. Five days after inoculation both species of *Phytophthora* were easily re-isolated from the margins of the brown areas, demonstrating that both *Phytophthora parasitica* and *Phytophthora palmivora* are capable of causing fruit rots.

II. Lemons.

Fruit of Meyer's Chinese lemon and the Sicilian lemon were inoculated with *Phytophthora parasitica* from grapefruit gummosis lesions. Both varieties were completely destroyed in nine days and a profuse growth of white mycelium was produced on the surface of the decaying fruit. In the later stages, secondary organisms (chiefly *Aspergillus niger* and *Penicillium* spp.) were present.

III. Eggplant Fruits.

Eggplant fruits were inoculated with both *Phytophthora parasitica* and *Phytophthora palmivora* (B5 strain). The former caused a rapid soft rot and finally complete destruction of the fruit in seven days, whereas the latter proved non-infective (Fig. 10). It may be mentioned, however, that strains of *Phytophthora parasitica* which will not attack the eggplant fruit and strains of *Phytophthora palmivora* which will attack it are known.

IV. Cacao Pods.

It was also shown that neither of these strains of *Phytophthora parasitica* or *Phytophthora palmivora* is capable of rotting a cacao pod even when the inoculum is placed in a wound. This is remarkable since this strain of *Phytophthora palmivora* in morphological and cultural studies has been classified as a member of the 'cacao group' of the species.

In a parallel series of inoculations using a strain of *Phytophthora palmivora* isolated from a cacao pod rot, infections developed rapidly, and produced typical 'black pod' in less than a week.

8. Summary and Conclusions.

1. A brief account of the taxonomy of three species of *Phytophthora* concerned in gummosis diseases of citrus is given.

2. The symptoms of gummosis disease in Trinidad on 'Marsh' grapefruit and other citrus varieties are discussed.

3. An account is given of the methods used in isolating species of *Phytophthora* from the lesions caused by gummosis on the trees and from rotten fruit. It was demonstrated that active mycelium of *Phytophthora* is only present towards the periphery of the lesions.

4. Cultural investigations proved that two species of *Phytophthora* (later identified as *Phytophthora parasitica* Dastur, and *Phytophthora palmivora* Butler.) are associated with the disease. So far *Phytophthora citrophthora* (Sm. and Sm.) Leon. has not been found in Trinidad.

5. In infection experiments it was demonstrated that both species of *Phytophthora* cause gummosis of 'Marsh' grapefruit trees and brown-rot of the fruit. In the field *Phytophthora parasitica* is mainly responsible for gummosis while both species are equally important in the production of brown-rot of fruit. The two species produce identical symptoms and accordingly can only be distinguished by careful cultural studies.

6. Inoculation of various other fruits showed that the Trinidad strain of *Phytophthora parasitica* can cause a rapid rot of lemons and eggplant fruit; but that both species of *Phytophthora* are incapable of rotting cacao pods even when placed in wounds, although morphologically this strain of *Phytophthora palmivora* belongs to the 'cacao group' of the species.

Acknowledgments.

In conclusion the author wishes to thank Mr. S. F. Ashby of the Imperial Mycological Institute for the identification of the species of *Phytophthora*; Mr. N. Wright of the Botany Department for taking many of the photographs; the Botany Department for the loan of the trees used in making the inoculation experiments; and the owners of citrus estates in Trinidad for their helpful co-operation in carrying out this work.

References.

1. Smith, R. E. and Smith, E. H.—A new fungus of economic importance. *Bot. Gaz.* XLII, pp.215-221, 1906.
2. Fawcett, H. S.—Two fungi as casual agents in gummosis of lemon trees in California. *Phytopath.* 3, pp. 194-195, 1913.
3. Fawcett, H. S.—Gummosis of citrus. *Journ. Agric. Research* XXIV, pp. 191-325, 1923.
4. Sherbakoff, C. D.—Buckeye rot of tomato fruit. *Phytopath.* VII, pp. 119-129, 1917.
5. Leonian, L. H.—Physiological studies on the genus *Phytophthora*. *American Journ. Bot.* XII, 7, pp. 444-498, 1925.
6. Dastur, J. F.—*Phytophthora parasitica* nov. spec. A new disease of the castor oil plant. *India Dept. Agric. Memoirs Bot. Ser.* 5, pp. 177-231, 1913.
7. Butler, E.J.—Report of the Imperial Mycologist. *Ag. Res. Inst. Pusa. Sci. Repts.*, pp. 68-85, 1918-1919.
8. Tucker, C. M.—Taxonomy of the genus *Phytophthora*, de Bary. *Univ. Missouri Agric. Exp. Stat. Research Bulletin*, 153, 1931.
9. Baker, R. E. D.—Gummosis of citrus in Trinidad, I. 'Marsh' Grapefruit on Sour Orange Stock. *Tropical Agriculture* XI, 9, pp. 236-239, 1934.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Polarization of Raw Cane Sugars, using Wet and Dry Clarification.—*F. W. Zerban.*

The N.Y. Sugar Trade Laboratory has tested 1,525 routine samples, taken at random, using dry and wet clarification. As a general rule, 1 c.c. of basic lead acetate solution is used per normal weight, or 2 c.c. with very dark sugars; the corresponding quantities of Horne's dry lead being 0.3 and 0.6 grms. Tests were made in duplicate, the two readings checking within 0.1 degree to be averaged.

Results are summarized in the accompanying table :—

Origin of Samples.	No. of Samples.	Average Pol. Lead Solution.	Average Pol. Dry Lead.	Difference.
Cuba	505	96.7853	96.6209	—0.1644
Puerto Rico	291	96.9818	96.8493	—0.1325
Philippines	596	96.9570	96.8322	—0.1248
Hawaii	59	97.8941	97.7932	—0.1009
Louisiana	7	96.7071	96.6214	—0.0857
Florida	27	97.5870	97.4796	—0.1074
British West Indies	25	96.4760	96.3420	—0.1340
Peru	3	96.8500	95.7500	—0.1000
Natal	12	97.5000	97.3667	—0.1333
General Average		96.9454	96.8072	—0.1382

It is seen that the average result of the precipitate error for the Cuban sugars is surprisingly high, 0.1644, whereas the results for the remaining countries vary from 0.0857 to 0.1340, and average 0.1261. These Cuban sugars were very dark in colour (having been stored from the 1931 to 1932 campaigns) and required a larger quantity of lead subacetate solution for clarification. This raised the polarization above that which would be obtained with the smaller quantity of lead required if the sugar had a normal colour. When an equivalent amount of dry lead is used, some fails to react and the polarization result is lower but still represents the actual polarization more closely.

The difference between dry and wet lead clarification generally becomes smaller as the polarization of the sugar rises. But polarization is not the only factor to be considered, elimination of impurities in the manufacturing process playing an important part. This is clearly indicated by the fact that the Natal sugars, although polarizing over a per cent. higher than the British West Indian sugars, nevertheless show about the same precipitate error. The error for the Louisiana sugars is only about half of that for the Cuban sugars, although their average polarization is slightly lower. The Peruvian sugars, with an average polarization below 96, give an error of only 0.1000, about the same as that of the Hawaiian sugars, with an average polarization close to 98.

The results obtained thus fully confirm those found in Czechoslovakia* and in Java†, that the volume error in the polarization of raw sugars after clarification with lead subacetate solution is considerable and must be corrected for. When the volume error is corrected, the error in the Ventzke scale should also be corrected at the same time. As long as clarification with lead solution is adhered to, it is best also to retain the Herzfeld-Schönrock scale, with the normal weight of 26.000 grams, because the two errors very nearly counterbalance each other for the average raw sugar being produced at the present time.—(*International Sugar Journal*, Vol. XXXVI, No. 432, 1934, pp. 493).

* *I.S.J.*, 1933, p. 483; 1934, p. 35.
† *I.S.J.*, 1933, p. 385.

AGRICULTURAL LABOUR IN TRINIDAD.*

BY

C. Y. SHEPHARD.

Part II.—Indentured Immigration.

THE development of agriculture in Trinidad has been so intimately connected with East Indian indentured immigration that it is impossible to appreciate the present situation without some knowledge of the immigration system.

I. RECRUITMENT.

The recruitment of indentured labourers in India was under the charge of officers appointed by the Secretary of State for the Colonies and paid by the Colonies for which they recruited. Emigration was supervised by the Protector of Emigrants, and the Medical Inspector of Emigrants, both appointed by the Government of India. Headquarters were established at Calcutta, the principal port of embarkation, and Madras. Originally, one agency was maintained for Trinidad, Fiji, Mauritius, and Jamaica, and another for British Guiana and Natal, but subsequently the two were amalgamated. The congested districts of the United Provinces, Bihar and Madras, formed the principal areas of recruitment, in which some thirty sub-depots were established. Over 600 licensed recruiters were employed by the various sub-agents.

Economic conditions in the recruiting districts largely determined the difficulty or ease of securing the numbers required. In prosperous years considerable difficulty would be experienced, while in years of poor harvests an excess in numbers would readily be forthcoming. An attempt was made to regulate recruitment by varying the rates of commission by which the sub-agents and recruiters were remunerated (1), and the numbers were further adjusted by raising or lowering the medical standards at the port of embarkation. Since the sub-agents were paid only for those willing and accepted as fit to emigrate at the port of embarkation the varying severity of the medical tests rendered recruitment a speculative occupation open to abuse (9). An attempt was made to recruit only agriculturists, or those who would readily take to such work, but sometimes the difficulties of recruitment led to the inclusion of individuals who not only refused to work as field labourers, but also attempted to persuade members of lower castes not to do so. The regulations required the recruitment of at least 40 females to every 100 males in order to prevent the social problems experienced in Chinese emigration which was almost exclusively male. The recruitment of women was encouraged by payment of a higher commission and the reduction of the period of indenture from five to three years. The difficulties of securing sufficient women were so great that undesirable types were occasionally included.

The majority of the emigrants were recruited in the towns, to which they were driven by depressed conditions in their native villages. They were drawn from over one hundred different castes, of which the most prominent were Chamars, Koris, and Kurmis. Complaints were frequently made of their physical unfitness for field work, and many had subsequently to be returned to India (2), (3), (4). Latterly, the greater vigilance exercised at Calcutta, coupled with the declining numbers required, resulted in the recruitment of physically better types. Planters generally preferred those castes which supplied the village menials of India. Some considered the Madrassis poor in physique, dirty in their habits and dwellings, inclined to indulge excessively in rum and to become drunk and unruly. Many managers denounced them as lazy and troublesome, but some found them satisfactory. Similar differences of opinion existed with regard to the hill tribes of the Punjab who, although of excellent physique, were impatient of control and resented fancied injustice. Strict disciplinarians, on the other hand, found them very reliable workers. The majority of the immigrants took readily to agricultural work and to the discipline of the indenture system.

II. CONDITIONS OF INDENTURE.

On their arrival in Trinidad the labourers were allocated in family or friendly groups to the various estates. They were required to live on the estate in dwellings provided by the employers. The Immigration Ordinance (8) required a floor space of 50 sq. ft. to every adult, or of 120 sq. ft. for three single men, or for a man and woman with not more than two children (Part V, Section 34). Normally the dwellings consisted of ranges of compartments, or 'barracks,' each room being 10 feet by 12 feet, constructed of wood, and roofed with smooth or corrugated iron sheeting. Frequently the floor space exceeded the minimum required by the Ordinance. Each room was provided with a covered gallery, or verandah, some 6 feet or 4 feet in width, intended for the purposes of cooking and of storing firewood. Suitable latrines had to be provided. Water was provided by collection from the roofs in suitable storage tanks, by streams, or by special ponds. The employer was responsible, under penalty, for keeping the buildings in repair, and the surrounding yard and grounds drained and clean. Housing was provided free of charge both to indentured and unindentured East Indians, and also to West Indians. Messrs. McNeill and Chimman Lal reported that "the housing and sanitary conditions are very much better than those to which the labourers are accustomed" (11).

* Continued from January issue, pp. 3–9.

Each estate was required to maintain a hospital with the necessary staff and equipment. Labourers were entitled to treatment, and maintenance while in hospital, free of cost.

The newly indentured labourers were unaccustomed to regular work and wages and, with characteristic frugality, were inclined to deny themselves the food necessary to maintain their health and strength. Employers were therefore required to supply rations, at a reduced rate for adults, and free of cost for infants, during the first twelve months. Wages were fixed at 25 cents (1*s.* 0½*d.* sterling) for a day's work, though on most estates the labourers were frequently given the opportunity of performing task work at which they could earn higher wages. The labourer could be required to work at least six days a week during the reaping period, and five days a week during the remainder of the year. The daily working period extended over nine hours which included a compulsory mid-day break of half-an-hour which normally extended to an hour. The labourer was permitted to work not more than fifteen hours a day but could not be compelled to work more than nine hours (Sections 124-128). The immigrant was entitled to a full day's work or wages on every day except Sundays, authorised holidays, and days rendered unsuitable for field-work on account of weather conditions, though he seldom endeavoured to enforce this right.

Penal clauses affecting both employers and indentured immigrants were inserted in the Immigration Ordinance. The fact that labourers under indenture received lower wages provided them with an inducement to desert, while their ability to subsist on the earnings of three days' work a week encouraged them to restrict their working days. The employer incurred considerable expense in introducing the indentured immigrant and the penal provisions constituted, in the last resort, his only method of enforcing the agreement. While discipline could not be maintained without a certain number of prosecutions it became clear that excessive use was made of these rights. After 1916 imprisonment for breaches of the Ordinance was abolished, and all prosecutions had to receive the previous approval of the Immigration Department. This effectively reduced the number of prosecutions.

III.—Advantages of the System.

The indenture system assured the estates a regular supply of labour, which could be increased as required by applying for additional immigrants. Moreover the supply of labour could be varied according to the seasonal requirements of the estate provided the indentured labourer's wages averaged 6*d.* a day. Days spent in hospital or gaol did not count in assessing this average so that little difficulty was normally experienced in maintaining the minimum legal earnings. During the crop period the indentured labourer could be called upon to work six days a week, and was easily persuaded to do overtime. He had to perform any reasonable agricultural task assigned him, so that a shortage of a particular type of worker was seldom experienced. Provided the employer observed the regulations of the Immigration Ordinance he was in no danger of losing his indentured labourers as the result of their dissatisfaction, or the superior attractions of other estates. Unindentured labour, both East and West Indian, was also flexible in supply, because these labourers were always in fear of having their places taken by indentured immigrants if they failed to please the employer. They were therefore obliged to accept such work as was offered. In general the system provided the employer with an adequate, flexible, and amenable supply of labour.

To the indentured immigrant the system provided fairly regular work at wages which enabled him to live in relative comfort. He was in no danger of being dismissed the estate and could not be dispensed with entirely during seasonal fluctuations in employment. During sickness he was entitled, free of charge, to maintenance and medical attention. Thus he was assured of profitable employment during health, and maintenance during sickness.

At the expiration of the indenture period the immigrant became entitled to a certificate of exemption from labour which placed him in exactly the same position as other independent citizens, except that, after a continuous residence of ten years within the island, he became entitled, on payment of part cost, to a return passage to India (7). Between 1851 and 1932 more than 50,000 East Indians were repatriated taking with them over £700,000 in cash, and a large quantity of jewellery.

Table 2.—Amounts to Credit of Repatriated East Indians. (6)

Period.	No. of East Indians.	Amount of Cash.		
		£	s.	d.
1851-1859	1,788	39,867	7	6
1860-1869	1,195	30,331	8	9
1870-1879	2,770	65,245	16	2½
1880-1889	5,047	108,684	8	10
1890-1899	7,297	98,364	2	6
1900-1909	7,397	116,303	2	3½
1910-1919	3,928	57,985	14	8
1920-1929	10,049	193,976	12	0
1930-1932	1,616	16,316	0	0
Totals	50,197	£727,074	12	9

The facts that these repatriates had to pay part of their return expenses and were able to save, in addition, considerable sums of money, distinguish them as industrious and valuable workers. Their skill and habits of regular industry rendered them highly valuable to the estates, and latterly, to induce them to remain in the island, the employers offered them small areas of land, either rent free

or at a nominal rent, for the cultivation of cane or food crops. Some estates laid out house and garden lots, while others erected houses which they rented to the labourers at reduced rates. With this encouragement many undertook the cultivation of sugar cane for sale to the factory.

Table 3.—East Indian Canefarmers. (12).

Period.	Annual Average No.
1898-1907	4,350
1908-1917	8,171
1918-1927	12,320
1928-1932	11,888

Although a wide range of occupations was open to East Indians whose indentures had expired, the majority, with their descendants, continued as agriculturists. Many remained on the estates to which they had been indentured, while others purchased land and cultivated on their own account. In 1927 East Indians were estimated to own 99,783 acres of which 53,000 were in cacao, 12,000 in sugar-cane and 9,000 in rice (5). East Indians also own practically all the small dairies in the island. That East Indians prospered in these occupations is illustrated by the fact that between 1882 and 1932 they remitted £142,000 to India.

Table 4.—Remittances to India. (4)

Period.	Amount Remitted.	No. of Remittances.
	£ s. d.	
1882-1889	15,336 13 6½	3,746
1890-1899	27,496 7 9¼	8,232
1900-1909	29,988 6 1	9,950
1910-1919	35,357 1 0	7,612
1920-1929	28,747 15 10	6,827
1930-1932	5,920 2 11	1,676

At 31st December, 1932, £164,139 stood to the credit of East Indians in Government Savings Banks, and a considerable sum in other Banks.

Table 5.—Deposits of East Indians in Government Savings Banks. (5)

Years.	No. of Depositors.	Balance to Credit at 31st December.
		£ s. d.
1884	1,499	42,012 10 10
1890	2,758	69,043 9 9½
1900	5,367	97,902 19 1½
1910	8,568	124,3 6 1 5½
1920	13,214	207,249 3 8
1930	12,651	153,847 9 11
1932	13,062	164,139 0 0

Although relatively few have adopted occupations other than agriculture some are profitably employed as merchants, shopkeepers, doctors, barristers, school masters and civil servants, while 90 per cent. of the motor 'buses are owned by them. Many examples of exceptional prosperity might be cited. Messrs. McNeill and Chimman Lal recorded one immigrant in receipt of £2,000 a year, and others with annual incomes varying between £500 and £1,250 (11). One East Indian canefarmer reaps over 10,000 tons of sugar cane yearly, the minimum value of which is £6,000. Three members of this community are members of the Legislative Council.

The condition of East Indians in Trinidad provides a remarkable contrast with that of the classes in the congested districts of the United Provinces and Bihar (4), (13) from which they were recruited. Cheap land in Trinidad offered them an escape from the economic bondage of the subdivision and fragmentation of holdings prevalent in their own country. Emancipation from the more rigorous caste restrictions widened their economic horizon. The habit of regular industry, developed during their periods of indenture, coupled with their improved physical and mental capacities, consequent upon better food and regular medical attention, have enabled them to take advantage of these greater opportunities. The indenture system benefited not only the estates but also the immigrants both during, and after, the period of indenture.

IV.—Termination of the System and its Consequences.

In 1917 the Government of India, in response to strong political agitation, terminated the system of indentured emigration. Some of the criticisms of the system were based upon incorrect data (9), and upon conditions which did not obtain in Trinidad. The principal objections were of a social and political nature.

The effect upon Trinidad has been profound. The system no longer stands between the efficient and inefficient estate. Competition for labour, practically non-existent under this system, is becoming severe. Estate owners were able to indulge in the cultivation of crops which required a highly flexible supply of labour. The labour demands of other industries had no important reaction upon agriculture as long as indentured labourers could be obtained. There was no immediate incentive to provide attractive conditions for unindentured labourers while equally good labourers could be secured from India. On this account many labourers were allowed to leave the estate and cultivate for themselves without any serious effort to retain their services. During periods of slackness inadequate work was provided in the certain knowledge that labourers could always be obtained as and when required.

To-day labourers are able to leave the estate to accept better conditions, knowing that they cannot be replaced by indentured immigrants. The higher wages and better conditions of other

industries are attracting labourers from agriculture. Estate managers are finding it necessary to provide more regular work during the slack periods in order to retain the services of the labourers for the busy season. Housing and other conditions of living are exerting a considerable influence upon the supply of labour for particular estates. Repatriation is continuing and competition for labour increasing. Employers are faced with the necessity of so modifying their conditions of employment that they may compare favourably with those offered by other industries and occupations.

The termination of the system has resulted in the wider choice of employment. The mobility of labour has increased. Motor 'buses, which ply to almost every part of the colony, enable the labourers to take advantage of the differential rates of pay offered by the estates. Since the labourers are no longer in fear of being replaced by indentured immigrants they are beginning to insist upon particular types of work, and greater regularity of employment, as conditions of residence. In agriculture the principal competition now is not for employment buy for employees. The labourer, and not the employer, now dominates the situation.

Addendum.

V.—The Consequences of the Depression.

To-day it seems incredible that only five years ago the planters were experiencing an acute shortage of labour. The fall in the price of cacao has necessitated a drastic reduction in expenditure on labour. Most of the cacao cultivation has passed the peak of its production under the existing system. The declining yields will be accentuated by the neglect of the past years. Probably at least a third of the existing area will have to be abandoned unless prices rise to an unusually high level. The spread of witchbroom (*Marasmius perniciosus*) will accelerate the rate of contraction. The smaller area will provide less employment. The desperate financial condition of the cacao industry has given a great impetus to scientific research which in due course may fundamentally affect methods of cacao production. Progress with an orchard crop must inevitably be slow. The depression has induced planters to diversify their cultivation by the development of coffee, limes, grapefruit and bananas. These new cultures will assist to counteract the diminished demand for labour for cacao cultivation.

The effect of the depression upon the sugar industry has been remarkable. The expense of manufacturing the cane into sugar at one time constituted one-half of the total cost of production. Important modifications in machinery and the introduction of chemical control had reduced operating costs to one-quarter of the total. There had been no corresponding change in the methods of growing sugar-cane. The running and overhead costs of manufacture per ton of sugar are greatly reduced when the factory operates at its optimum capacity. The companies have reduced their unit costs of production by increasing their supply of cane. Improvements in mechanical cultivation, comprehensive financial control and scientific research into methods of production have effected extraordinary reductions in the cost of cane production. In the canefarming industry the provision of compensation to farmers for the unexhausted value of their cane cultivation on eviction, and the policy of the companies to pay not less than $2.64 per ton of cane has given great stability to the industry. Despite the low price of sugar-cane the farmers are producing quantities which have caused some embarrassment to the factories. The production of sugar has risen to over 100,000 tons during the past four years but this has not been reflected in a corresponding increase in the provision of employment. Nevertheless the heavy labour requirements of cane cultivation and the increased production of sugar have been factors of vital importance in easing the labour situation. The death of the sugar industry, which at one time appeared imminent, would be an irreparable catastrophe to the island.

The phase of rapid extension in the oil industry has been exhausted and has given way to a steady and systematic exploitation of the available resources.

Despite the increasing total population, the number engaged in agriculture is declining. Large numbers of East Indian agriculturists have been repatriated. A return to a profitable level of prices in the cacao and sugar industries would result in a rapid expansion in the demand for labour and lead to a recurrence of the shortage of 1928 and 1929. The sugar industry has attained an efficiency regarded as impossible a few years ago. The costs of production compare favourably with any other part of the world, but sugar has ever been the shuttlecock of politics, and the industry is not enjoying that measure of prosperity to which its efficiency would appear to entitle it. If economic factors ever became dominant the industry in Trinidad would receive an enormous fillip which would enable it to provide employment for the entire agricultural population of the Colony. The effect of the repatriation of East Indians would then be felt in an acute form.

Summary.

I. Recruitment.

Under the indenture system labourers for the estates were recruited under the control of Government officials.

The recruits were obtained chiefly from the lowest agricultural castes of the most densely populated parts of India.

II. Conditions of Indenture.

The Immigration Ordinance required the labourer, under penalty, to work as required at any reasonable task assigned him, and the employer to provide suitable housing, a reasonable amount of work at fixed rates of wages, and adequate medical facilities.

III. Advantages of the System.

The system provided employers with an adequate, amenable, and flexible supply of labour, and eliminated competition with other estates and industries.

Labourers, during their indenture, were assured of adequate wages while at work, and maintenance and medical attention during sickness.

IV. Termination of the System and its Consequences.

Since the termination of the system the competition between estates, and between agriculture and other occupations, has become severe.

The mobility of the labourers has increased and they are beginning to exercise considerable influence over the terms of their employment.

V. The Consequences of the Depression.

The depressed prices of agricultural products has resulted in serious under-employment. It is unlikely that the demand for labour by the cacao industry will attain its previous dimensions in the immediate future. The expansion of the sugar industry and the development of new crops have eased the labour situation. An improvement in agricultural prices would lead to a recurrence of a shortage of labour. The removal of political interference with sugar production would enable the Trinidad industry to employ all the labour available in the Colony.

Literature Cited.

1. Aspinall.—*The British West Indies*, Pitman, 1912.
2. Immigration.—No. 93* of 1900, p. 2.
3. Immigration.—No. 104* of 1901, p. 4.
4. Immigration.—No. 78* of 1904, p. 15.
5. Immigration.—No. 72* of 1933.
6. Immigration.—Annual Reports from 1882 to 1932.
7. Immigration Ordinance.—No. 161.
8. Immigration Ordinance.—No. 26 of 1916.
9. Indian Indentured Emigration.—No. 68 of 1916
10. Keatinge.—*Agricultural Progress in Western India. Longmans, Green & Co.*, 1921.
11. McNeill and Chimman Lal.—*Indian Immigration.*—No. 87* of 1915.
12. Proceedings of the Agricultural Society of Trinidad and Tobago.
13. Singh, Kunwar Maharaj.—*British Guiana in* 1925. Dated India Office 18th December, 1925.

* These numbers refer to Council Papers of the Colony of Trinidad and Tobago.

FOR SALE.

First Annual Report on Cacao Research, 1931, 44 pp. 1 plate. *Price* 1s.

Second Annual Report on Cacao Research, 1932, 40 pp. 4 plates. 34 figs. *Price* 5s.

Third Annual Report on Cacao Research, 1933, 72 pp. 3 plates, 4 diagrams. *Price* 5s.

To be obtained from the Editor *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

MISCELLANEOUS NOTES.

Cacao Fermentation in West Africa. By *A. W. Knapp.*—(*J. Soc. Chem. Ind.*, May, 1934.)

The author introduces his study by a brief review of the West African industry in which he points out how greatly the quality of this cacao, from the manufacturer's point of view, has improved since some method of fermentation, however crude, has been used. He gives a description of the more common methods practised, namely the heap, pit, wooden box, basket and bamboo frame. The first two are so obviously unsound that they should be abandoned. Experiments were conducted with the remaining methods and although fermentation by the 3-tier box system was best, both the basket and the bamboo frames were better than nothing. The essential in whatever method may be used is careful mixing to ensure adequate aeration. It was found that daily turning was not necessary and the author suggests careful turning at 48 and 96 hours after the start. In six days under these conditions fermentation should be satisfactorily completed. Lack of adequate turning results in loss of uniformity, some beans being over and others under fermented. Bad or careless fermentation results in growth of moulds and germination. As yet no method of short-circuiting this six-day slow fermentation has proved successful in producing a well-cured product.

F. J. P.

* * *

The Fly Nuisance.

In an article entitled "Our Filthy Flies: how to get rid of them" R. M. Washburn points out* that much can be done towards diminishing the nuisance. By cleaning up refuse so as to destroy breeding places, the eggs laid die before maturing; and in some places, eggs and maggots may be killed by sprinkling well with powdered borax and chloride of lime. Flies that develop should be caught in standard inexpensive fly traps. Every door and window should have screens. Flies are just as anxious to get out of a room at times (*e.g.*, on light clear mornings) as they are to get in at other times, of which advantage can be taken. This is easily done by cuttting the screen in short slots or slits near the top frame, and bending the top edge inwards, and the bottom edge outwards in a slight curl downwards. Then the inside fly walking up finds a hole and escapes; but the insect outside crawls up near the dark top piece to meet a wall made of the screen bent in a slight curl downwards. Over this roll he does not crawl, but instead pursues his way further down the outside screen. One of the most effective fly-poisons is sweet skim-milk in a saucer with which 2 or 3 c.c. of formaldehyde has been mixed.

* *Agriculture and Live-stock in India*, 4, No. 3, pp. 315-318. Fuller information is to be found in U.S. Public Health Service, Supp. No. 29; and U.S. Dept. of Agric. Farmers Bulletins Nos. 734, 1097 and 1498.

THE WORLD'S COTTON POSITION.

II.—The Current Season.

American *v.* Outside Growths.

By John A. Todd, m.a., b.l.

In the previous article, which appeared in the January issue, the writer brought his survey of the World Cotton position down to season 1933-34. It remains to show how that position has been affected by developments regarding the current season, 1934-35. These developments date back to October, 1933 when the United States Government introduced a new and most drastic plan for restriction of acreage in 1934, and possibly also in 1935. Their experience in 1933, however, had shown that even a reduced acreage might produce a crop larger than was desired, owing to a bumper yield, and this time they were determined that they would also restrict the crop itself. In January, 1934, a new measure was thus introduced which came to be known as the Bankhead Act, under which the amount of the crop to be ginned and marketed (except under prohibitive taxation) during the season, was restricted to ten million bales.

The first result of all this legislation was that when the Government's estimate of acreage was published early in July it appeared that the area had been restricted to 28,024,000 acres, but even this with a normal yield would have produced a crop slightly in excess of the Bankhead quota. Then Nature again took a hand in the game. Even before the acreage figures were announced reports were coming through from the wheat belt of a very serious drought which threatened to extend to the western parts of the cotton belt; and when the first Bureau report on the cotton crop appeared on 8th August, the figure was only 9,195,000 bales. The result was a sharp rise in prices which carried them up to the high levels referred to in the first article.

Later in the same month the United States Government took one more step in their policy of bolstering up the price of American cotton, which must be explained here because it has now become almost the dominant factor in the whole position. The explanation carries us back to 1929 when they first started this policy of agricultural relief. The earlier stages of that policy were described in an article* by the writer in this Journal, but the essential fact from the present point of view is that that policy resulted in the Government becoming, during the seasons, 1929-30 and 1930-31, the effective holders of over three million bales of cotton, most of which had cost them about 16 cents per lb. This Government cotton hung over the market during the next two years until in the spring of 1933, as part of the inducement offered to the planters for the "special abandonment" scheme of that year, the balance of nearly two million bales was handed back to the planters under an "option" at a price of six cents. In the autumn of 1933, however, the Government started a new plan of advancing to the planters a sum sufficient to enable them to hold their cotton, and the basis price fixed was ten cents. As a result the Government not only became responsible for more cotton, but also had to advance to the holders of the option cotton the difference between the six cents at which they had taken it over and the new basis price of ten cents. Finally, in August, 1934, the Government announced their intention of repeating a similar loan policy for that season's crop, but the basis price was fixed at 12 cents and this price was to be paid not only for new season's cotton but also for the two million bales of the option cotton previously pledged at ten cents. The price being then well over 13 cents the market naturally assumed that the Government offer of 12 cents would mean in effect the pegging of the price at that figure as a minimum; but once more cotton showed its inveterate capacity for doing the unexpected. The drought in the west broke in August and since then every succeeding monthly report has raised the crop forecast, until when the first "estimate" was published in December the figure proved to be 9,731,000 bales. The result was that cotton prices began to sag and as soon as they got down to the level of the Government peg the Government began to find themselves receiving large offers of cotton under the loan scheme. By the end of November they had already received over three million bales, making the Government's total holding fully five million bales with the option cotton, and it was expected that this holding would increase still further.

Then the Government began to realise the probable consequences of their policy. Already, during the season 1933-34, the world's consumption figures had shown a definite swing over from American to Outside Growths. This was specially marked in the second half of the season and in the first three months of the current season estimates show that the position is becoming very serious indeed, especially as during the three months June to August, 1934, the authorities of the N.R.A. Code had imposed a 25 per cent. restriction on spindleage activity throughout the American industry; and this had hardly come to an end when it was followed by a nation-wide textile strike which resulted in still further curtailment of cotton consumption in the United States.

Thus the United States Government found themselves in a very serious dilemma. Increased consumption of Outside Growths at the expense of American was resulting in a heavy reduction of American exports and practical strangulation of the demand for American cotton in its normal

* "Cotton Prices". Vol. VII. No. 12, Dec., 1930, pp. 226-331.

markets abroad. Everyone in America realised the danger of this situation, which was the direct result of their policy of restricting cotton production and inflating the price. It was therefore very strongly urged that this policy must be abandoned in 1935 and the American crop allowed to recover to such a figure as would enable it to compete in the world's markets with Outside Growths. But that meant a lower price for the 1935 crop, and when quotations for October, 1935 appeared on the Futures markets in New York and New Orleans this was shown in a heavy discount on these distant futures. That of course was a very serious business for the Government, who were adding to their holding at a price now well above anything they could hope to get for that cotton later on, if they abandoned their restriction policy. The Government eventually announced on 1st December that they would enforce for 1935 the maximum reduction which they had power to call for under the original agreement of October, 1933, namely 25 per cent. from the basic acreage of the average of the years 1928-1932. This it is generally agreed will mean an acreage of at least 33 millions in 1935 and, if the yield should prove to be in line with the ten years' average, a probable crop of 12 to 13 million bales.

In the meantime there have been other developments with regard to the position of supply of Outside Growths. In the case of Egyptian the second Government estimate which is now available places the crop at 7,640,000 kantars against 8,411,000 last year as the result of a small reduction of acreage and weather conditions during the summer which were on the whole rather unfavourable. For India there is no crop forecast available yet, but the second estimate of acreage showed an increase of only 2.8 per cent., and it is now doubtful whether this year's crop will show any increase on that of 1933-34. As regards the other larger items among Outside Growths the Chinese crop this year is likely to establish a new record at nearly three million bales and the Russian, though rather disappointing will not be much below last year's figure. But the most striking development of the season is the Brazilian crop which from a normal figure of about 600,000 bales seems to have shot up last year to 800,000 or 900,000 bales and it is said may amount this year to 1,200,000 bales.

Taking the Outside Growths as a whole therefore the prospective total production for the coming season is about 14 million bales against about 9½ millions of American ! Such a position, quite apart from any artificial support of American prices like the Loan plan, was bound to affect the relative prices of American cotton and Outside Growths, and the following table, in which the prices of Outside Growths are given as percentages of American, gives some idea of the extent of the change since the beginning of last season.

Liverpool spot prices of American with other varieties as percentages (Last Friday of each month.)

Season.	American Middling Actual.	Indian No. 1 Fine Oomra.	West African Mid.	Brazil Pernam Fair.	East African G.F.	Peruvian Tanguis Good.	Uppers F.G.F.	Sakel F.G.F.
1933.	Pence per lb.			Percentages on American.				
August	5.53	79.6	101.3	103.1	115.7	124.8	122.4	136.0
September	5.60	80.7	100.9	103.6	114.3	124.1	114.6	132.0
October	5.54	78.3	100.0	102.7	113.5	122.6	111.0	127.4
November	5.09	77.6	100.0	102.9	114.7	120.6	112.6	137.7
December	5.33	75.6	100.0	100.9	114.1	124.4	113.5	145.2
1934.								
January	6.07	74.0	99.2	99.2	111.5	120.6	109.9	140.4
February	6.67	73.2	98.5	97.8	107.5	118.0	107.9	136.6
March	6.35	70.1	98.4	94.5	107.9	118.9	108.0	137.6
April	5.88	70.9	100.0	94.9	109.4	121.3	106.5	137.2
May	6.20	75.2	99.2	95.2	108.9	120.2	107.6	135.8
June	6.84	73.2	99.3	95.6	107.3	118.3	102.8	122.1
July	6.97	72.5	98.6	96.4	106.5	117.2	104.0	122.0
August	7.11	70.5	99.3	96.5	105.6	116.2	105.1	122.9
September	6.91	69.8	99.3	96.4	106.5	116.6	103.9	121.7
October	6.92	68.1	98.6	95.7	107.2	114.5	105.2	118.8
November	6.96	70.7	98.1	95.3	106.8	114.7	108.8	129.3

Unfortunately no detailed statistics of world's consumption will become available until after mid-season when the Federation statistics appear, but Garside of the New York Cotton Exchange Service publishes monthly estimates from which the following summary has been prepared. This shows that the tendency to substitute Outside Growths for American which was increasingly shown throughout the whole of last season, has been carried still durther during the early months of this season and is likely to continue. It will be noted that during the first quarter of this season the estimated world consumption of Outside Growths was actually greater than that of American.

At the end of November, however, there was some sign of a reaction, partly attributable no doubt to the difficulty, especially in Lancashire, of getting sufficient quantities of Outside Growths suitable for their needs, and the prices of these growths were stiffening. At the same time the deadlock in the American market, due to the higher prices asked in America owing to the Government loan and the impossibility of shipping cotton to Liverpool, showed signs of bringing matters to a real test of the American Government's policy. It was of course arguable that with such a small crop the price of 12 cents was not artificial but entirely reasonable, and that while spinners had been very quick to take advantage of the cheaper supplies of Outside Growths, drawing on their mill stocks for what American cotton they required, this could not go on indefinitely. It is therefore impossible at the moment of writing to take any dogmatic view as to the prospects of cotton prices, especially beyond the current season. For this season the supply position is approximately known, and it seems to be generally assumed that the American Government peg at 12 cents will be effectual during this season. But the cotton trade is never content to confine its forward vision to the current season, for consumption and prices during each season are more and more affected as the season advances by the prospects of the following season. All that can be said at the moment is that prospects at present indicate a world consumption this season of American cotton of about 12 million bales, which should leave a Carryover at the end of the season of about eight million bales. With a crop of even 12 or 13 million bales in 1935 that will leave the position of supply in the following season practically as it is this season, namely a total season's supply (*i.e.* crop plus carryover) of about 20 million bales.

There are still two unknown quantities in the problem as regards next season. First, will the American Government renew the Bankhead Act quota ? On that point the procedure is that the planters must give a two-thirds majority in favour of continuance and that plebiscite is being taken in December. But after that the President must fix the amount of the quota for the coming season. In 1934 it was ten million bales (of 500 lb. net). In 1935 it might easily be 12 millions, and that may not be known till 1st April when the quota must be announced. Second, will the American Government continue their loan policy into season 1935-36, and at what price ?

World's Consumption. American v. Outside Growths. (000's omitted). (New York Cotton Exchange Figures).

	American.			Outside Growths.	All Kinds.
	U.S.A.	Other Countries.	Total.		
1933-34.					
August	572	690	1,262	917	2,179
September	487	708	1,195	848	2.043
October	490	713	1,203	925	2,128
1st Quarter	1,549	2,111	3,660	2,690	6,350
2nd do.	1,298	2,142	3,440	2,912	6,352
3rd do.	1,494	1,991	3,485	2,951	6,436
4th do.	1,213	1,882	3,095	3,028	6,123
Season's Total	5,554	8,126	13,680	11,581	25,261
1934-35. *					
August	410	570	980	956	1,936
September	290	556	846	1,028	1,874
October	507	572	1,079	1,115	2,194
1st Quarter	1,207	1,698	2,905	3,099	6,004

* Subject to revision.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Experiments on Nitrification in Soil.

The Report for 1933 of the Government Chemist, Wellcome Tropical Research Laboratories, Sudan (Chemical Section, Publication No. 67) contains an interesting account of investigations concerning the important processes of nitrogen transformations in soil, and the effects of temperature, water-logging, and the presence of non-nitrogenous organic matter on these processes.

The total nitrogen present in soil at any instant occurs in different forms, of which three are simple compounds, namely "free ammonia" (ammonium salts), nitrites and nitrates. In addition, a large proportion of the total nitrogen occurs as complex compounds, probably similar to proteins. A part of this may be liberated as free ammonia gas by distilling the soil with alkaline permanganate. For convenience, this part may be termed "albuminoid ammonia", a term which probaby has little true meaning. The rest of the total nitrogen may be termed "residual nitrogen".

The first determinable stage in the nitrification of ammonium salts in the soil consists in the formation of nitrites, the amount of which rapidly rises to a maximum and then falls to nearly zero. During the early stage of this transformation, nitrates and "free ammonia" remain nearly constant in amount, but, during the later stage, nitrates increase very rapidly at the expense of "free ammonia", and their formation continues until nearly all of the "free ammonia" has disappeared. Under certain conditions, the amount of nitrate produced is less (sometimes very much less) than the equivalent amount of "free ammonia" that has disappeared. Measurements show that this nitrate is gradually converted into "residual nitrogen," and is not lost in the form of free nitrogen gas.

Effects of Temperature.—Nitrification experiments conducted at 25°, 30°, 35° and 40°C on soil to which 200 parts per million of nitrogen in the form of ammonium sulphate had been added, gave the following results. (1) Nitrite formation proceeds more rapidly the higher the temperature and the maximum is greater in magnitude, and is attained much more quickly, than at lower temperature; (2) the formation of nitrate commences earlier, and also its rate of production increases, with rising temperature; (3) the rate of conversion of nitrate into "residual nitrogen" is low at 25°C as compared with that at 40°C, at which it proceeds almost as rapidly as nitrate is formed; (4) the amount of "albuminoid ammonia" remains almost constant throughout these changes.

Effect of Non-nitrogenous Organic Matter.—The addition of 0.35 per cent. of cellulose (filter-paper pulp) to soil containing added ammonium suphate undergoing nitrification (*i.e.*, conversion into nitrate), enhanced the conversion of nitrate into "residual nitrogen". (Hence, buried fresh plant-residues at first deplete soil of its nitrate, a fact well known to agriculturists).

Effect of Waterlogging.— Waterlogging was found to inhibit the conversion of ammonia (present as added ammonium sulphate) into nitrate, and appeared also to favour its conversion into "residual nitrogen".

Nitrification of Protein.—The nitrogen content of a sample of protein (wheat gluten, 200 p.p.m of nitrogen) added to soil was rapidly transformed into "free ammonia" within 10 days, but nitrification was not evident until a further period of about 20 days had elapsed. The content of "albuminoid ammonia" in the soil rapidly returned to its initial value.

* * *

Tobacco; A New Source of Citric Acid.

The chief supplier of commercial citric acid for many years has been Italy, where the main source of the supply is lemons; in 1929, Italy exported 2,810 tons of citric acid. Countries requiring large amounts of citric acid have naturally sought to use their own raw materials, and numerous investigations have been made in order to discover suitable and cheap substances and simple means for their transformation. In the United States of America, as well as in Europe, molasses have been successfully employed for many years as a source of citric acid. The application of a fermentation process, involving the fungus *Aspergillus niger*, for converting the sugars in molasses into citric acid was first attempted in 1893. Since then, the process has been put on a sound commercial basis, and the product has competed severely with the natural citric acid obtained from citrus fruits, such as lemon and lime.

Recently, tobacco has been employed as raw material for the manufacture of citric acid in Soviet Russia. Low grade tobacco may contain as much as four per cent. of citric acid combined with bases to form citrates. Some strains, such as Mahorka, contain up to eleven per cent. (Lime juice contains about seven per cent. and lemon juice, between two and six per cent. of citric acid). A high degree of correlation apparently exists between the amount of citric acid present in tobacco leaves and the content of mineral substances (ash), as well as the content of nicotine. Hence the citric acid content of tobacco may be increased within certain limits by heavy manuring with suitable mineral substances. Mahorka tobacco may be used, not only as a profitable source of citric acid, but also as a source of nicotine. This additional purpose increases the commercial value of the plant, and lessens the cost of the citric acid manufactured from it. The process of extraction is very simple and inexpensive, and involves no fermentation stage. (*Indus. Engin. Chem., News Edit.*, 20th August, 1934.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR :—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.) :—

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
29th November	4	3¾	8	0¾
6th December	4	3¾	8	0¾
13th December	4	3¾	8	0¾
20th December	4	3	8	0
27th December	4	3¾	8	0¾
3rd January	4	5¼	8	2¼
10th January	4	6	8	3¾
(*11th Jan.*, 1934)	4	7½	9	6¾

The end of the year has brought some improvement in the sugar situation. The tone of the market which closed steady was distinctly better while sellers have shown more resistance. 1934, however, will be remembered as a period of disappointment and delayed expectations. The American market has been rather firmer with sales of Cuban up to 1.73 c. cost freight. It is expected that the new Cuban crop will be fixed at about 2,200,000 tons.

* * *

COCOA :—Due to orderly marketing of the Accra crop, which is now in full swing, the market has been well maintained, and for this grade of cocoa prices improved, the latest quotation being 23*s.* 3*d.* This factor has had a steadying effect on all other grades, and with increased consumption in the United States of America and Germany, the two largest users, indications point to better prices.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association :—

	American Mid.	*Egyptian F.G.F. Sakel.*
30th November	6.96	9.00
7th December	7.02	9.13
14th December	7.08	8.97
21st December	7.15	9.00
28th December	7.16	—
4th January	7.21	—
11th January	7.16	—
(*12th Jan.*, 1934)	5.88	8.53

American cotton prices have been steady with limited trading, the markets being rather in need of a stimulating influence. There appears to be little likelihood of any distinct change in prices in the immediate future. West Indian has been quiet but a sale of 60 bales of Montserrat at 14*d.* has been made.

RUBBER :—Quotations for Plantation Sheet have ranged as follows :—

	pence per lb.
28th November	6 3-16
5th December	6 3-16
12th December	6 3-16
19th December	6 3-8
27th December	6 3-8
2nd January	6 1-4
9th January	6 11-16
(*10th Jan.*, 1934)	4 3-4

After a decline in values prices have now resumed a gradual upward trend chiefly as a result of a recovery of confidence in the goodwill and ability of the Dutch Government to carry out their part of the regulation scheme and also because of an improvement in the American situation. Consumption figures in U.S.A. for November, 1934, have been estimated at 34,842 tons, while total consumption for the first eleven months amounted to 419,335 tons against 374,179 tons for the same period in 1933.

* * *

BANANAS :—Jamaicas continue in fairly good demand at the unchanged price of £17 5*s.* per ton delivered London or £17 nearest station Provinces. Brazilians continue to be quoted at £18 nearest station.—(*West India Committee Circular*, 20th December).

* * *

COFFEE.—At the end of 1934 the market closed in a state of depression chiefly owing to the absence of demand from Germany. Costa Rica kinds have during the last few months been difficult of sale. Superior Santos is quoted at 47*s.* 6*d.* to 48*s.* as against 39*s.* 6*d.* to 40*s.* in 1933.

* * *

LIME JUICE :—Quoted at 1*s.* 9*d.* to 2*s.* 3*d.* per gallon as value on landed terms of fair to good green juice. Also some enquiry on c.i.f. terms at 2*s.* per gallon for good quality.

* * *

LIME OIL :—Distilled very quiet, 20*s.* per lb. asked but no buyers at that price. Handpressed, last business was at 35*s.* per lb., landed terms.

* * *

COPRA.—According to *Gillespie Bros. & Co. Ltd.*, the market has displayed a firmer tone, West India descriptions improving to £10 per ton c.i.f. London/Liverpool.